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Conditioning Woody Basketry Elements with Water and Ethanol An Investigation into the Effects of Existing Conservation Methods

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Conditioning Woody Basketry Elements with Water and Ethanol
An Investigation into the Effects of Existing Conservation Methods

A thesis submitted in partial satisfaction
of the requirements for the degree Master of Arts
in Conservation of Archaeological and Ethnographic Materials

by

Hayley Monroe

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ABSTRACT OF THE THESIS

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Master of Arts in Master of Arts
in Conservation of Archaeological and Ethnographic Materials
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Professor Ellen J. Pearlstein, Chair

Baskets are prone to damage caused by the alternate swelling and shrinking of fibers due to fluctuations in relative humidity. At the same time, this sensitivity has long been used to the conservator's advantage. The chemical composition of cellulose, specifically its ability to form, break, and reform hydrogen bonds, allows for both water and polar solvents to infiltrate, swell and plasticize dried plant tissue. Humidification (or conditioning when using solvents) has become a standard conservation procedure in the re-shaping of damaged basketry in museum collections. However, concerns have been raised over microbial growth, and also the potential for irreversible swelling of the basketry elements. As a result, polar solvents – in this study ethanol specifically – have been added to or become a preferred conditioning media instead of water. This project revolved around the design of an experiment to track the extent of swelling and subsequent recovery of basketry samples made from two woody species treated with water and ethanol vapor. These species sampled were willow (Salix spp.) and spruce (Picea spp.), which occur with some frequency in the basketry traditions of the western United States and Canada. The extent of swelling before and after the conditioning process between all the samples was compared, using measurements taken with a Keyence VHX-1000 Digital Microscope. The results of this study not only corroborate data within conservation, material and forestry science literature, but also point towards clear trends which can inform the conservator's decision-making in planning humidification/conditioning treatments of basketry made from woody plant species.

The thesis of Hayley Monroe is approved.

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1. Introduction

Basketry is one of the oldest and most widespread of human technologies. Nearly every culture has produced baskets from plant-derived and other materials, and for many cultures today, basketry remains a living and thriving tradition still passed from generation to generation. Despite the breadth of basketry material and large variety in plant species and other flexible materials worldwide, this study will focus on North American basketry produced with minimally-processed plant elements of species common to basketry of the Paiute and Tlingit cultures.

Basketry defined

In 2008, G. Ward, author of *The Grove Encyclopedia of Materials and Techniques in Art* succinctly defined basketry as “artifacts of more or less rigid construction produced by the interlacing of linear materials” (G. Ward 2008), however experts in the study and classification of basketry had, previous to this, produced much more nuanced definitions which better encompass features important to the understanding of basketry as a distinct technology. For example, a basket can be defined as having been hand-woven from plant-based elements without the aid of a frame or loom (Adovasio 1977), or as Dr. Willeke Wendrich further clarified, as a “class of artifacts made out of vegetable fibers of limited length or with a shape which is specific to the raw material” (Wendrich 1991). The mention of limited length is important because, as Wendrich points out, it helps highlight the distinction between basketry and textile technology – which while sharing many technological similarities, uses prepared fibers of ‘limitless’ length. Of course basketry can be made from materials which are not plant-based. Anything flexible and of limited length can and has been incorporated, however, for the purposes of this study, plant-based basketry is the class of object in question. From the conservation point of view (which is concerned with how the composition of materials influences physical stability and treatment) the use of non-plant-based materials places a basket into the category of composite objects, for which the kind of immersive vapor treatment which will be discussed below is not appropriate. I briefly address composite objects again below in the discussion section where I discuss the thought-process of choosing appropriate treatment methods for any kind of basket.

Basketry in museum collections

Many museums in the United States and Canada have large and comprehensive basketry collections, representing a large number of indigenous groups and cultures. Some of these baskets are archaeological – whether from the arid South West or the much wetter North West coast – others were actively sought by private collectors, anthropologists and museums in the 19th and 20th centuries (Crawford 1986). Increasingly, many museums are trying to strengthen relationships with indigenous and First Nation communities and in turn, are trying to fold regular consultation and communication into the decision making process from acquisitions to exhibition to conservation and to repatriation[1]. No longer just curiosities or objects of beauty, baskets are more and more seen and treated as *belongings* and representatives of their original community and individual weaver (Salick et al. 2014; Ogden 2004; Wolfe and Mibach 1983)

Like all other museum objects, baskets are subject to conservation efforts to ensure their long-term preservation as well as, at times, their suitability for display. This study will look into aspects of the specific treatment referred to in the literature as humification (in this study

1 The Museum of Anthropology (MOA) at the University of British Colombia is one such museum which has sought to adopt this much more nuanced relationship with the baskets housed in its collection.

referred to as conditioning to take into account the use of non-aqueous solvents) and the effects on certain chosen basketry plant fibers. The term ‘conditioning’ is borrowed from Ruth E. Norton in Florian et al. (1990) in which she makes the distinction between water and solvent plasticization.

Baskets are highly sensitive to fluctuations in relative humidity (RH). Relative humidity is defined as the ratio of water vapor in the air to the equilibrium vapor pressure of water at a given temperature, or in other words, the amount of water in the air compared to the maximum amount of water the same volume of air could hold at that temperature, which is given as a percentage.

Fluctuations in RH can cause damage to basketry in direct and indirect ways: by either causing direct mechanical damage to the cellular structure of the wood or indirect damage by initiating or fostering microbial attack. It is recommended that basketry be stored within a range of 50±5% RH with the caveat that baskets originating in extremely arid or extremely wet environments may be more stable if the RH is adjusted to be closer to the average RH of the regions of origin (Ogden 2004; Norton 1990). However, generally speaking, if conditions are too humid (above 65%), the elements can both swell and harbor destructive microbial growth, if too low (below 40%)[2], water loss causes shrinkage, embrittlement of the cellulosic structure and loosening of the weave. Most damaging of all are frequent fluctuations between extremes of high and low RH, the stress caused by the repeated swelling and shrinking of the structure causes fractures and mechanosorptive creep which leaves basketry deformed or increasingly vulnerable to mechanical damage.

2 These values are taken from the 2010 Canadian Conservation Institute *Care of Basketry* note http://canada.pch.gc.ca/eng/1439925170228

The following table highlights the optimal RH range for basketry as well as the specific dangers posed by conditions that are either too humid or too dry.

Relative Humidity and its Effect on Plant-Based Basketry Fibers	
0-10%	Completely dry (ovendry) cellulose is very brittle and inflexible (M.-L. Florian, Kronkright, and Norton 1990) Below 40% RH so much water is lost from plant fibers that shrinkage and embrittlement can cause substantial mechanical damage (CCI Objects Conservation Lab 2017)
10-20%	
20-30%	
30-40%	
40-50%	Below 55% RH fungal spores cannot become active (Abe 2009). 50±5% RH generally recommended as the optimal range for objects made from plant fibers (Norton 1990)
50-60%	
60-70%	Above 65-70% RH Molds and other microorganisms can readily grow (CCI Objects Conservation Lab 2017; Norton 1990). Of particular concern are baskets with food residue – while microbes are able to digest the plant fibers themselves, the addition of food residue increases the risk of microbial growth. It is often inappropriate to clean off such traces of use, and the carbohydrates, proteins and other nutrients are very attractive to microbes, and the higher the humidity, the greater the risk of growth (Ogden 2004).
70-80%	
80-90%	
90-100%	

This sensitivity to RH is used in the conservator's favor. Because the chemical composition of cellulose allows for both water and polar solvents to render dried plant tissue temporarily pliable, a sometimes referred to as plasticization, conditioning has become a standard conservation procedure in the re-shaping of damaged basketry within the museum lab setting. However, concerns have been raised, partly over the initiation of microbial growth, but also of the potential for irreversible swelling of the basketry elements. As a result, polar solvents, especially ethanol or isopropanol, are preferred conditioning media in some labs, such as those at the Arizona State Museum. Others are concerned that the use of solvents strips the natural extractives from the fibers as well as dries them excessively potentially causing embrittlement.

The focus of this thesis is to to investigate the extent of potentially permanent swelling of plant fibers while undergoing conditioning. The mechanism behind conditioning and reshaping basketry lies in the breaking of hydrogen bonds between cellulose fibers, their temporary occupation by water or a solvent and subsequent reestablishment of these bonds between the cellulose polymer chains once a basket has been physically reformed while malleable (Banik, Brückle, and Daniels 2011).

The research for this thesis included experiments designed to track the extent of swelling and subsequent recovery of basketry samples (treated with water and ethanol) representing two plant species which occur with some frequency in the basketry traditions of the western United States and Canada. *Recovery* should not be confused here with *drying*, as it refers to the conditioned object's return to equilibrium with the ambient environment rather than a removal of all liquid. Many of the wood-swelling studies cited in this paper refer to samples as *oven-dried* which means all free liquid has been removed, and is a laboratory-induced state, one which basketry objects do not naturally experience.

These studies on the swelling of plant tissues has been produced by groups in the fields of forestry and material science as well as in conservation (Meier, Kaps, and Kallavus (2005), Mantanis, Young, and Rowell (1994) and Gilberg (1986) respectively). This study is attempting to approach the issue of swelling from the specific perspective of conservation.

The species chosen include spruce root *(Picea spp.)* from the American northwest, Canada and Alaska, and willow *(Salix spp.)* from central California. These were chosen due to the frequency with which they are encountered in the basketry of museum collections. Therefore tracking swelling changes of these specific species will hopefully be as useful as possible while also encouraging subsequent avenues of inquiry. They also represent both softwood (gymnosperms, or conifer such as spruce) and hardwood (angiosperms, or broad-leafed plants including willow). As will be discussed below, the differences in properties between the two are very important.

Samples of both basketry (aged, and potentially deteriorated) and non-woven reference material from the UCLA/Getty Conservation Training Lab were used in this study. Originally a third species, the Southern Californian grass called juncus (*Juncus textilis)* was to be tested as well, however experimental difficulties resulted in it being dropped from the study.

The extent of swelling before and after the conditioning process was compared between basketry and non-basketry samples of both spruce root and willow, conditioned with de-ionized water (DI H_2O), ethanol (EtOH), and three mixtures of the two, 70:30 H_2O:EtOH, 50:50 H_2O:EtOH, and 30:70 H_2O:EtOH.

Techniques used to track dimensional changes in the samples include the following:

Imaging and taking measurements with a digital microscope and micrometer – This is the primary technique used in this study. Basketry samples were monitored for dimensional changes and measured before, during and after the conditioning process while in small custom made chambers which could hold 70% RH and fit beneath the objective of the microscope without being opened. The microscope, a Keyence VHX-1000 Digital Microscope is capable of stitching composite images of 3-dimensional surfaces and its built-in software is able to then allow measurements of distances between points in microns (µm). The composite images correct for the otherwise difficult depth of field which makes using single photographs of such surfaces impossible to use for the measurement of distances which are not on the same vertical plane[3].

3 Such work has been successfully carried out by various conservators such as Cacciari et al. on the monitoring of surface roughness before and after the laser cleaning of archaeological bronzes (Cacciari et al. 2012).

Photographic tracking[4] **–** The simplest way to observe possible changes is to photograph each sample before and after treatment with a reference grid placed below. This was done to monitor for readily visible (macro) dimensional changes such as warping.

Scanning electron microscopy – SEM imaging was used on a small subset of the samples in an effort to see more clearly the potential damage induced to the cell wall structures by the conditioning in this study. For example, the hope was that if solvents caused embrittlement, that this potential desiccation of the fibers, while perhaps invisible under ordinary visible light magnification, might be visible using SEM. A similar study on the swelling of pine was conducted by a materials and polymer research group based at Tallinn University of Technology in which SEM images were successfully used to evaluate damage to cell walls post swelling (Meier et al. 2006; Meier, Kaps, and Kallavus 2005). Various other studies have used SEM imagery successfully to evaluate experimental results, for example, Elizabeth Boyce from Queens University in 2012 who studied the use of sucrose to bulk waterlogged basketry samples and used SEM imaging to evaluate the resulting structural integrity of the treated samples (Boyce 2012).

The goal of this research project was to evaluate potential damage caused by existing aqueous and solvent conditioning techniques for the conservation of basketry, namely the use of water and or ethanol. Conditioning is a common procedure undertaken in conservation labs seeking to reform distorted and damaged basketry, but so far it is both understudied and under-documented in the available literature. This research seeks to evaluate existing methods and to

4 This technique was chosen because of its successful use in other basketry or plant-material related studies. For example, UCLA/Getty conservation student Nicole Ledoux used a similar technique in the evaluation of materials in her 2012 Master's thesis. Visual monitoring for warping due to RH fluctuations has also been successfully used in the monitoring of Australian bark paintings (N. Smith and Roth 2002), in this case the changes in dimension were literally traced periodically onto mylar beneath the works.

hopefully identify trends which point to the best approach out of those currently being explored in various labs.

These results will help to quantify the efficacy or inherent risks of each conditioning technique and to determine which, if any, is best. This will furthermore help to inform future approaches to conservation treatments of basketry materials.

2. Background

Baskets have played a central role in cultures throughout the world and throughout time and have filled every possible niche in daily life from storage and transportation of food or goods, to vessels for cooking, traps for hunting and fishing, implements for gathering and preparing food, furnishings for dwellings, cradles for infants, as well as highly admired objects of status and beauty intended to showcase an individual weaver's skill. The cultural significance of baskets cannot be understated, to the point that it influenced Dr. Wendrich's 2012 definition of the technology as "...made of interweaving strands that form a fabric. One strand keeps the next in place and creates a system of interconnections, which in a larger frame also encompasses the life of the basket makers and the society in which they live" (Wendrich 2012). The vital role of baskets in daily and spiritual life is particularly evident in the still extant and vibrant weaving traditions of Native American and First Nations cultures of North America, many of whom are represented in museums around the world by their basketry.

The following sections will provide a systematic review of the available literature on the topic of basketry conservation – in particular conditioning – as well as relevant chemistry and research from other conservators and forestry scientists.

2.1 Conservation of Basketry

The conservation of basketry is generally focused on the stabilization of the structure of the object. While damage or stress to individual woven elements can have a huge impact on the entire system (for example initiating cracking, warping or slumping), damage at the molecular level can likewise cause instability – such as the deterioration of the cellulose supporting the cell walls by acid hydrolysis, the stripping of soluble protective extractives from the fibers by solvents, or the massive and disruptive swelling induced by exposure to a strong alkali.

The conservation of basketry borrows heavily from textile and paper conservation which both deal with similar structures and materials.

Overview of deterioration issues typical to basketry

Baskets, as mentioned just above, are woven objects composed largely of cellulose-based plant elements – lengths or sections of plants including but not limited to roots, stems, leaves, rhizomes, bark and seedpods (Anderson 2005). These elements are usually minimally processed (meaning that while they are shaped and manipulated to suit a weaver's needs, they are generally not greatly chemically altered from their original form). Any number of other materials can also be incorporated into the structure, either as true woven elements alongside the plant fibers or as decorative elements or functional additions such as handles. Examples include hide or leather, feathers, shells (Pomo gift baskets), porcupine quills, textile, and even, more recently of course, synthetic materials. As a result baskets can be truly composite objects from a conservator's point of view. However, basketry is best understood as being a largely plant-based technology and the deterioration mechanisms and condition issues observed in basketry are largely based upon the cellulosic nature of the materials. Baskets are therefore prone to the deterioration mechanisms typical of cellulosic materials such as acid hydrolysis, photo-degradation, swelling-shrinking cycles induced by fluctuations in RH, bio-deterioration, etc.

Other factors which influence the rate, severity, or type of deterioration include the proportions of materials other than cellulose – in particular hemicellulose, lignin and extractives – in the plant tissue and the degree to which any traditional processing (before the manufacture of a basket) has removed these. The fact that pre-weaving processing as well as previous conservation treatment can both potentially strip plant fibers of these materials (altering their responsiveness to conditioning) will come up several times in this study, although it poses larger and very interesting questions which while noted, could not be fully explored within the limited scope of this project.

Unlike the processing of other plant materials, for example the retting (fermentation) of linen for textile fibers to remove all other materials from the cellulose fibers, the processing of basketry fibers does not seek to greatly change the composition or working properties of the plant elements. Generally the processing of basketry elements includes some combination of stripping, splitting, drying (seasoning) and rewetting to ensure equivalent size, length and pliability as well as even shrinkage of all the fibers used in a weaving session. The intention is to coordinate desired properties of strength, flexibility, appearance etc. over a collection of otherwise largely un-altered material which may not have been gathered all at once.

If stored in favorable conditions baskets can remain sound for a very long time – some of the oldest baskets found in arid conditions in Egypt are straw coiled examples from Fayum which date to the neolithic, roughly 4,200 BCE (Wendrich 2008), however if the conditions are less ideal, the plant tissues can deteriorate quickly either by mechanical damage induced by extreme drying or frequent fluctuations between extremes in RH, or by microbial attack during periods of elevated RH.

Brief overview of conservation treatments past and present

Before looking more closely into the history of conditioning as a conservation treatment, a brief overview will be given of the conservation of basketry, which will help to put conditioning in the wider context of overall treatment.

Conservation treatments of basketry generally seek to address surface cleaning, tear repair, loss compensation, construction of supports or mounts, as well as drying (often in the case of waterlogged archaeological examples), consolidation (again, often in the case of waterlogged archaeological examples which once dry might be very fragile), and of course, the conditioning and reshaping of distorted or crushed baskets.

These treatments can vary depending on factors such as whether the basket in question is whole or fragmentary, stable or actively deteriorating, modern or historic, or archaeological (which generally implies either waterlogged or desiccated). There are also issues surrounding the stakeholders involved with a basket, particularly when working with indigenous peoples for whom basketry is both part of their heritage and a still living tradition. In these cases, questions arise around whether or not treatment should be pursued or if a basket should be allowed to remain unaltered and to allow time and nature to take their course.

Conditioning is a treatment which has evolved out of a long history of techniques intended to restore pliability to an object's underlying cellulosic structure. While today a more minimally invasive approach is preferred, basketry conservation has included treatments such as applying coatings as well as bulking or consolidation with materials such as poly(vinyl acetate) emulsions, polyester resins, polyethylene glycol (PEG) and Paraloid B-72 (C. W. Smith 2003; Wendrich 1991; Adovasio 1977; Schaffer 1976). In particular, polyethylene glycol (PEG) became popular in the 1970's as a treatment to restore permanent flexibility to brittle baskets (Boyce 2012) and lower molecular weights are still used to help retain flexibility in water-logged baskets as they are dried (Boyce 2012; Senge and Carrlee 2010; Schaffer 1976). This hydrophilic polymer replaces water in the cellulosic structure, preventing shrinkage (during drying) and imparting flexibility similar to that imparted by water. It has been used extensively in the treatment of waterlogged wood as a replacement for water to preserve dimensional integrity, while in desiccated materials such as baskets, it has been used to impart permanent flexibility to the brittle woven structure (Schaffer 1976).

However, as with any consolidation treatment, the use of PEG to impregnate a basket or any other porous object is irreversible, and once undertaken can never be undone. And while fairly chemically inert, the presence of PEG has been observed to cause secondary problems in other areas of conservation such as increased accumulation of dust[5]. As conservators began to favor less invasive treatments, the use of permanent plasticizers like PEG was replaced by

5 Once introduced into a system as a consolidant or plasticizer, PEG remains tacky. This stickiness attracts dust and particulates to the surface of the object and which in time darkens and soils the surface http://cameo.mfa.org/wiki/Polyethylene_glycol. Accumulated soiling can also further initiate chemical reactions which initiate or accelerate the deterioration of the object itself (*Dust and Brush Vacuuming*, Western Australian Museum, https://www.youtube.com/watch?v=nBTUKkSPG0s&list=PLKsvb3AsMnZSsmOROOXNHTVnGQuVOYeVG, accessed on July 19, 2017)

humidification with water and conditioning with solvents – neither of which leaves lasting residues within the material structure.

3 Literature review of conditioning

Conditioning – as a systematic conservation procedure we recognize today – has a fairly long though intermittently documented history. It seems to have developed out of a convergence of several related areas of conservation; the conservation (or rather restoration) of wooden objects, the permanent plasticization (alongside reshaping for display or study) of desiccated archaeological baskets (ie. with PEG), as well as humidification procedures developed within the fields of paper and textile conservation.

Any cellulose-based or other organic hygroscopic material can be conditioned (that is, temporarily plasticized) with water and or polar solvents.

As for basketry, the specific goal of conditioning is to plasticize the cellulosic micro-structure in order to facilitate recovery of the original shape of the object. Because the plasticization is temporary, the restored shape is set as the water or solvent evaporates from the system. The methods by which this suppleness is achieved as well as the degree to which any collateral alteration to the object is acceptable have changed over time as conservators build upon the work of previous practitioners and as attitudes towards acceptable alteration become more culturally nuanced and chemically exacting. The following is an attempt to gather together the published literature as well as correspondence with conservators well-versed in conditioning treatments within their own collections.

Steaming is the first method to appear in the literature – not only in conservation publications but also in more general formats in which it was recommended to the private owner as an easy home remedy to preventing embrittlement (Foreman 1971). Steam not only provides moisture but also heat which speeds the plasticization process – it has been used for centuries to bend and shape wood (Wright, Bond, and Chen 2013). Forestry and polymer scientists Mantanis, Yong and Rowell published a paper, *Swelling of Wood Part III. Effect of Temperature and Extractives on Rate and Maximum Swelling*, in which they illustrate how the addition of heat greatly increases the swelling factor of not only water but also of polar organic solvents (Mantanis, Young, and Rowell 1995).

Steaming was adapted from traditional carpentry techniques and by extension the conservation/restoration of wooden objects and furniture. However steam can be a harsh medium, and the risk of tide-lines and water stains due to the collection of condensation on an object's surface was fully acknowledged and eventually by the 1980's lead to its abandonment (Gilberg 1986; Kronkright 1981). In the 1970's, as mentioned above, there began a trend to permanently impregnate baskets with flexible polymers like PEG. This indeed produced results which mimicked the suppleness of fresh material, however, the irreversibility caused it to fall from favor in the 1980s as the desire for temporary and reversible solutions grew (Appelbaum 1987). The addition of the documentation of rapid oxidation of PEG at temperatures as low as 75°C used to melt off excess during treatment (Padfield et al. 1990), further accelerated the abandonment of PEG as an all-purpose material for the preservation of basketry. The use of PEG survived only in situations involving the treatment of waterlogged objects in which a bulking agent is required to replace water upon removal from wet conditions.

In the late 1970's, Mary-Lou Florian (who would go on to co-author one of the seminal works on the conservation of plant materials) was systematically investigating the swelling effects of water and solvents on different types of plant tissue – and was already both sounding a note of caution about the deleterious effects of such swelling on basketry fibers and urging material literacy so that the conservator might have "an awareness of the potential chemical and physical hazards of treatments using solvents … and treatments which may cause differential stress, movement, and shrinkage of these plant materials because of their inherent structure or fabrication", as well as, "...it must be realized that wetting basketry will remove the crisp bends of the woven materials and cause different stresses and movements of various materials which is one of Nature's ways of enhancing deterioration" (Florian 1977). In the same year J. M. Adovasio was still recommending rather invasive conservation treatments relying heavily on the application of irreversible consolidants and biocides in his otherwise widely praised publication on the proper identification and analysis of North American basketry forms (Adovasio 1977).

In the 1980's, as the notion of reversibility took hold and treatments which left no residue gained favor, discussions continued to develop around the pros and cons of water vs. solvents, and like Florian had in 1977, conservators were taking a closer look at the composition of the materials at hand in individual objects. Dale Kronkright explored the effects of steam, polar and non-polar solvents on plant materials as well as temperature, rate, concentration of solvent etc. and cautioned that rapid swelling of any kind should be avoided (Kronkright 1990). A few years later, Gilberg published a paper advocating for the use of ethanol and methanol over water in the plasticization of suberin-rich (and therefore particularly hydrophobic) birch bark

(Gilberg 1986) which highlighted the existence of situations in which water could not be used at all.

In 1990 the most comprehensive publication focusing on the conservation of plant-based materials in cultural heritage was written by Mary-Lou Florian, Dale Paul Kronkright and Ruth E. Norton. In it, Kronkright takes a deep look at the chemistry of cellulosic tissues as well as, alongside Norton, systematically outlining the various risks posed by swelling (whether with water or polar solvents) on these tissues.

By this time the overall procedure of conditioning with vapor seems to have become fairly standardized and was being adopted beyond the conservation community in related fields such as archaeology. In 1991, Dr. Willeke Wendrich recommended a simple water-vapor-only method for archaeologists excavating basketry in arid environments and who might be required to carry out basic treatments in the field with or without conservators present.

Conditioning today

Today, conditioning is carried out in conservation labs as the first step in the reshaping of distorted, organic objects. Along with basketry, wood, leather, paper, textiles, feathers, and other soft, hygroscopic materials are treated with moisture to lend or restore temporary flexibility in order to reestablish a shape or to flatten creases or distortions. In plant-based materials, the introduction of a swelling agent lubricates the cellulosic structure and imparts suppleness and flexibility by temporarily breaking some of the hydrogen bonds between cellulose polymer chains, allowing the fibrils to slide past one another. Living plant tissue is full of free water (meaning water that is not chemically bound to the molecular structure of the tissue), for example, the sap in wood (Buck 1952), and without this water, plant tissues become stiff and brittle.

Two basic techniques are used to deliver conditioning media to a system, ie. a basket. If only localized treatment is required, for example to relax a crease, or if an object is made of multiple materials which cannot all be treated alike, then the media can be delivered in the liquid phase on blotter paper with a semi-permeable barrier layer such as a piece of GORE-TEX® which slows the transport of liquid and prevents flooding of the fibers. However, if the entire object requires treatment at once, it can be placed in a chamber in which the water and or solvent is present in the vapor phase (Wendrich 1991; Kotonski 2012; Banik, Brückle, and Daniels 2011). Vapor chambers are particularly useful when an entire basket requires re-shaping. In these cases, a non-permeable chamber is brought to about 70% RH with jars or pans of DI water placed around or below the object which is often on a platform or frame. Chambers can either be ready-made airtight containers, but are often custom constructions made from heat-sealable polyethylene sheeting and a frame made of PVC pipe, Ethafoam®, or any non-water-reactive and non-hygroscopic material[6].

Once conditioned and reshaped, an object such as a basket is allowed to recover, which returns the fibers to their equilibrium moisture content or EMC. As the polar conditioning medium or media dissipate, new hydrogen bonds are formed between the cellulose chains, allowing the new shape of the object to set and become rigid (Kronkright 1990). Using moisture or polar solvents to soften and reshape a basket is not dissimilar to the original processing,

6 In conversation with conservator Gretchen Anderson at the Carnegie Museum of Natural History in Pittsburg, Pennsylvania, she describes a basic custom vapor chamber format as being a PVC pipe frame with elbow connectors covered in a tent of heat-sealed polyethylene sheet. The progress of the conditioning is checked periodically, but not on a specific schedule, and are removed when the desired suppleness is reached.

drying, re-wetting fibers in preparation for weaving into a basket and so is considered fairly sympathetic to the material.

Because of the risk of inducing microbial growth, many conservators have elected to add ethanol as a biocide to kill both bacteria and fungi. While individual and lab preferences vary, the generally accepted proportion is 30% ethanol in DI water (though Sequeira et al. 2007, in particular, cites a concentration range of 60-70% ethanol in water as most effective for conservation treatments of paper). Ethanol is commonly used as an anti-microbial agent in aqueous treatments of objects, acting as both a fungicide and bactericide (Caneva, Nugari, and Salvadori 2008), most likely by causing the disruption of cell membranes and vital proteins (McDonnell and Russell 1999). It is unable, however, to kill fungal spores. It has been observed in both medical and conservation settings that 100% ethanol is a less effective biocide than mixtures with water and seems that "in the absence of water, proteins are not as readily denatured. These factors may afford an explanation why absolute ethanol, a dehydrating agent, is not as effective as water-ethanol mixtures" (Sequeira et al. 2017).

There are variations in the choice of swelling media. Dr. Nancy Odegaard at the Arizona State Museum has worked extensively on the continual modification of conservation techniques, and as early as 1999 was cautioning the general collecting public about the substantial swelling effect of water on basketry fibers (Odegaard 1999). As mentioned above, polar molecules other than water can produce similar results as long as they are small enough to penetrate the cellulosic structure. Other polar swelling media in use today include ethanol and isopropanol. While also being biocides, they, like water, possess the ability to lubricate the cellulosic structure of plant materials. At the same time, because they are both less polar than water, neither swells cellulose to the same extent.

However, there is reluctance to use solvents such as these. Norton cautions that "conditioning [with solvents] invariably involves some degree of swelling and deterioration of the cellulosic and/or extractive components" (Norton 1990). This potential loss of extractives is also mentioned by wood scientist George Mantanis et al. in the 1994-1995 series on the swelling behavior of wood, and he cautions that the loss of extractives can cause wood to become more responsive and prone to swelling. In the case of the Arizona State Museum, water was abandoned in favor of entirely non-aqueous methods[7] in order to both minimize swelling and to prevent microbial activity, two benefits seen to outweigh the risks such as solubilizing the extractives. Dr. Nancy Odegaard from Arizona emphasizes that these changes are small in comparison to the beneficial results of using ethanol (C_2H_6O)[8]. The reduced risk of extractive migration is probably due to the relatively small amount of solvent which penetrates and adsorbs onto the surface of the plant material when in the vapor phase. In contrast, exposure to liquid ethanol would flood the material with a much larger volume of solvent and presumably allowing for far greater disruption to the extractives within the system.

To date there have been few systematic studies published within the field of conservation effects of aqueous, non-aqueous, or binary solution conditioning on objects made of plant-materials. A couple of notable exceptions are Gilberg's 1986 publication on the plasticization of misshapen birch bark with solvent vapor and Baker and Grattan's 2011 conference proceeding on the dimensional changes induced in wood by consolidants in various solvents (Baker and Grattan 2011; Gilberg 2017). Beyond conservation, a large number of

7 The thought process and currently favored procedures at The Arizona State Museum are detailed in email correspondence with conservators Dr. Nancy Odegaard and Betsy Burr.

8 Most recently at the Arizona State Museum, isopropanol (C_3H_8O) has replaced ethanol as the solvent of choice. Both have lower swelling factors than water (due to both the larger molecular size and fewer active -OH groups than water, each having only one vs. water's two) while still imparting flexibility and which also act as useful biocides.

studies on the swelling effects of water and solvents on plant tissue, particularly wood, have come out of the forestry science and material science fields, mostly aimed at industrial wood processing (ie. for pulp). Many of these studies are extremely thorough and useful, gathering together a huge amount of information on the swelling behavior of various species of wood.

Of these studies, several stand out. In the mid 1990's, George Mantanis et al. published a series of articles on the wetting and swelling behavior of wood, not only in water but also in organic solvents. More recently, in 2005 and 2006 a team from the Tallinn University of Technology produced two papers specifically on the swelling of pine in binary aqueous mixtures with organic solvents, and successfully used SEM imaging to evaluate the resulting damage to the cell wall structures after multiple rounds of wetting (Meier et al. 2006; Meier, Kaps, and Kallavus 2005). Very recent work has been completed by cellulose chemists who have also investigated the interaction between more purified cellulose (ie. paper) and moisture, such as the work by Lennart Salmén and Anne-Mari Olsson in which they investigate the dimensional changes and mechanosorptive creep experienced by paper samples during and after adsorption of water (Salmén and Olsson 2016).

Much work has also been done on the alteration of the properties of wood during the aging process, from embrittlement to changes in hygroscopicity, and especially mechanosorptive creep, which reduces the swelling capacity of the tissue over time (Kránitz et al. 2016; Nilsson and Rowell 2012; Unger, Schniewind, and Unger 2001; Erhardt et al. 1996; Buck 1952). Mechanosorptive creep, in particular, is crucial to understanding the behavior of plant materials in the presence of swelling media. "Mechanosorptive creep ... is defined as deformation that occurs as a consequence of changes in moisture content of the material while subjected to applied forces" (Kronkright 1990). More importantly, Schniewind (1983) points out that mechanosorptive creep, a form of plastic (that is, nonelastic) deformation, takes place to a greater extent during periods of swelling agent adsorption and desorption than when the moisture content is constant. This obviously has a significant impact for the conservation of these materials, both in terms of the importance of protecting artifacts from changes in moisture content and for any efforts to reduce the extent of deformation in artifacts made from plant materials" (149).

According to Kronkright, as wood changes chemically during the aging process (undergoing deterioration mechanisms such as acid hydrolysis, oxidation, and physical creep), the amorphous areas of the woody structure become increasingly crystalline as the available -OH groups gradually bind to the molecules around them (particularly after repeated cycles of wetting and drying which disrupt and reform bonds between cellulose and hemicellulose strands). Over time the cellulosic structure becomes less responsive (due to the fewer available -OH groups) to the polar molecules which would otherwise cause swelling (Kronkright 1990).

The summary above highlights the research that has contributed to the development of conditioning as a conservation procedure. The safety and physical integrity of an object has always been paramount. And perhaps now that the effect of such a treatments are becoming more readily observable and quantifiable, it is no longer enough to say object 'seems' to have suffered no ill effects to the naked eye. The ability to measure with increasing certainty whether or not changes take place as a result of a treatment, is necessitating from an ethical perspective an investigation into possible causes of physical change to better inform our decisions regarding the lengths to which a conservation treatment such as conditioning should be pursued.

Potential pros and cons of conditioning treatments

There are several concerns associated with the introduction of water into the basketry fiber system. Solvents, especially ethanol, are helpful in mitigating these problems by adjusting the evaporation time when part of a mixed solution with water.

Effects of Water and Ethanol on Basketry

Swelling agent	Pros	Cons
Water	Introduction of water lubricates wood at molecular level, allowing the fibers to once again slide and flex as they did when the plant was living (although not to the same extent) (Mantanis and Young 1997; Mantanis, Young, and Rowell 1994; Florian, Kronkright, and Norton 1990) Does not alter the appearance of the basket (ie. no color change, as long as tide lines and water soluble dyes are carefully avoided)	Microbial growth (fungal or bacterial) can take hold in the moist environment, complicating conservation treatments and threatening the stability of the artifact, especially above 60% RH (CCI Note 2010; Florian, Kronkright, and Norton 1990) Water can dissolve certain components like starch as well as damage pectin and hemicellulose (Norton 1990). Water can draw dirt between and into the interstices of the fibers, making existing soiling more intractable and much more difficult to address (CCI Note 2010; Norton 1990). Swells the fibers, which can lead to mechanical damage (Florian 1977)
Ethanol	Provides anti-microbial properties (Sequeira et al. 2017) Imparts flexibility similarly to the way water does, by interacting with cellulose molecules (h-bonding), but to a lesser degree, and more slowly due to the slightly larger molecular size (Mantanis, Young, and Rowell 1994). Faster drying than water, leaves system more quickly.	Can cause excessive drying of the fibers which can then lead to embrittlement (Norton 1990) Can strip the fibers of natural soluble extractives (Norton 1990) Swells the cellulose structure (to a lesser degree than water) which like all swelling has the potential to cause damage (Norton 1990).

	Does not produce any color change after treatment as long as, as with water, tide lines and soluble dyes are avoided (Sequeira et al. 2017).	
Mixture (water + ethanol)	Produces a greater degree of swelling than either water or ethanol alone (Mantanis, Young, and Rowell 1994; Mantanis, Young, and Rowell 1994; Meier, Kaps, and Kallavus 2005) Provides antimicrobial protection that water alone cannot (Sequeira et al. 2017). Faster evaporation time than water alone (Meier, Kaps, and Kallavus 2005; Mantanis, Young, and Rowell 1994)	Produces a greater degree of swelling than either water or ethanol alone (Meier, Kaps, and Kallavus 2005; Mantanis, Young, and Rowell 1994). Potential dissolution and migration of soluble extractives (Mantanis, Young, and Rowell 1994; Norton 1990)

Conditioning and reshaping is by its nature an invasive treatment, and not only must questions be asked about the stability of the basket to be treated and whether it can withstand such a procedure, but also whether such a treatment is appropriate from a cultural perspective. While a conservator or a curator may see conditioning and reshaping as a ‘reinvigoration’ of an otherwise ‘damaged’ or ‘disfigured’ basket, care must be taken not to impose western ideals of display upon a basket which may hold more meaning for the community in its un-altered state.

4 Chemical composition of plant tissues

Cellulose is the primary structural molecular component of all plant tissue, retaining about 40% of the carbon in the plant world (Heinze 2015). Cellulose provides the strength and rigidity to cell walls which allows everything from short grasses to the tallest trees to grow upright against the force of gravity and likewise supports outstretched branches, it provides the framework for the vascular structures which allow trees and palms to grow to such great heights and still be able to transport water and nutrients, and helps to disperse the seeds of many species in the form of fluffy hairs which can catch the wind or be otherwise transported. Of all the organic compounds in the biosphere, cellulose is the most abundant (Heinze 2015).

Cellulose is also one of the most important natural compounds in cultural heritage: wooden structures and objects, cotton, linen and other fibers/textiles, paper, modern synthetics such as cellulose nitrate (a cellulose derivative), and of course basketry are all made from modified or unmodified plant tissue comprised of cellulose.

While some sources of natural cellulose are extremely pure such as cotton, most plant tissues are a much more complex system of compounds including varying quantities of hemicellulose, lignin, extractives, and ash (minerals). The chemistry of cellulose will be discussed in the next section, but first, its molecular partners, hemicellulose and lignin will be briefly mentioned.

Hemicelluloses are a collection of polysaccharides, similar in structure to cellulose though much shorter (having an average degree of polymerization of only 100-200) and tend to be branched. They occur within the cellulose network, inside the cellular lamellae and intermixed with lignin (Caneva, Nugari, and Salvadori 2008; M.-L. Florian, Kronkright, and Norton 1990). Hemicellulose is thought to aid in swelling because it is associated with the amorphous regions of cellulose where -OH groups are more readily available to interact with water or solvents. In the absence of hemicellulose, the cellulose structure becomes much more crystalline and rigid (Florian, Kronkright, and Norton 1990).

Lignin is an amorphous aromatic macromolecular compound, the exact structure of which is still not completely understood, but “is second only to cellulose in its contribution to the Earth’s biomass” (Caneva, Nugari, and Salvadori 2008). It provides additional rigidity to the cell wall structure and is very resistant to deterioration. Softwoods (conifers like spruce) have up to 10% more lignin than hardwoods (Florian, Kronkright, and Norton 1990), and being aromatic, it is hydrophobic and does not directly contribute to swelling although it can inhibit it.

Percentage chemical composition of softwoods and hardwoods

Wood	Cellulose %	Hemicellulose %	Lignin %	Trace substances%
Conifers (softwood)	40-45	20	25-35	<10
Broad-leafed species (hardwood)	40-45	15-35	17-25	<10
Chart reproduced from Caneva et al. 2008 which is in turn reproduced from Higuchi and Chang 1980				

Cellulose, hemicellulose and lignin are all crucial in the understanding of how plant tissue behaves once it is part of an artifact and how it deteriorates over time.

Equilibrium Moisture Content (EMC)

When discussing the swelling behavior of wood or other plant tissues, it is crucial to first understand the equilibrium moisture content, or EMC, which refers to the amount of water a material can contain at equilibrium. The EMC fluctuates depending on the relative humidity of the environment, and as such hygroscopic materials like cellulose release and absorb water from the atmosphere as the temperature and relative humidity change (Caneva, Nugari, and Salvadori 2008).

To clarify, when wood is fresh, or green, it contains both free water and bound water. Free water, the liquid in the vessels, is what evaporates first as the cut wood starts to dry. Crucially, no dimensional change is induced by the loss of free water. Once all the free water has evaporated from the system, and the remaining wood and bound water has reached the fiber saturation point (FSP), fluctuations in the amount of bound water are what cause the cellulosic structure to shrink or swell (Unger, Schniewind, and Unger 2001).

If all the bound water is driven out of the system (which can only be done in an oven) the wood reaches the state called ovendry. This can be very useful experimentally, as it provides a known starting point of zero moisture content, however was not used in this study because it is not the state in which baskets exist.

As with all instances of chemical equilibria, the EMC is a condition in which the system is in balance but can be adjusted. In this case, the EMC of a sample varies depending on the relative humidity of the environment. Wood which is at or below the FSP will then either adsorb or release moisture in order to reach equilibrium with the RH of the environment. If, for example, the RH were to rise in a gallery setting, the baskets would respond by adsorbing some of the water vapor in order to maintain equilibrium.

In this study, the samples are not described as 'dried' after conditioning, as this would imply the deliberate driving off of water, but rather 'recovered', meaning they are given 24 hours to return to EMC.

4.1 The chemistry and swelling of cellulose

Cellulose is a polysaccharide (a carbohydrate polymer) made up of repeating monomeric units of glucose with the chemical formula $(C_6H_{10}O_5)_n$ where *n* denotes the repetition or degree of polymerization of the monomeric glucose units to form long polymeric chains ranging from 1,000 to 30,000 units in length (Heinze 2015).

The individual glucose units form rings (D-glucose), with each glucose monomer rotated by 180° from is neighbor. In this way the long chain of a cellulose molecule is formed. Once part of the polymer chain, each D-glucose unit has 3 hydroxyl (-OH) groups remaining, making the molecule very polar, and these are available to form hydrogen bonds with neighboring cellulose chains forming fibrils and eventually larger fibers. Within the plant structure, the cellulose forms crystalline and amorphous regions. Within crystalline regions, most of the -OH groups are bonded to other cellulose chains forming a rigid network, while within amorphous regions, the -OH groups are either free or bonded to hemicellulose forming an amorphous, less crystalline, and therefore more flexible region. It is these amorphous regions and their available -OH bonds which are most susceptible to swelling if water, or another polar or semi-polar solvent small enough to penetrate the structure, is introduced (Banik, Brückle, and Daniels 2011; Mantanis and Young 1997; Kronkright 1990; McCawley 1977).

It is the highly polar nature of the cellulose molecule which is crucial to our understanding of its swelling behavior when in contact with water or other swelling agents (Baker and Grattan 2011; Banik, Brückle, and Daniels 2011; Kronkright 1990), however there are many factors which have been identified as also playing significant roles including dimensions of the wood microstructure, molecular size of the swelling agent, polarity of the swelling agent, temperature at which the wood is exposed to a swelling agent, presence of water in combination with a swelling agent, and presence or lack of extractives in the wood (Mantanis, Young, and Rowell 1994).

The amorphous regions of the cellulose structure swell the most out of all the molecular regions of a plant fiber. In these regions there are more hydroxyl groups available for hydrogen bonding with a polar liquid than in the crystalline regions in which most of the hydroxyl groups are occupied in bonding the cellulose chains to one another (Banik, Brückle, and Daniels 2011; Kronkright 1990).

Swelling of cellulose

Water (and other polar molecules) causes cellulose to swell by attaching to the active hydroxyl (-OH) groups located along the cellulose molecules. Many molecules are polar, including many solvents, however for molecules other than water to produce swelling, they must "follow the same physical-chemical pathways as water" (Baker and Grattan 2011), meaning simply that they must be physically small enough to be able to penetrate the cellulosic structure of a given plant-based material. The smaller the molecule, the deeper it penetrates, and the more bonds it is able to make with the cellulosic -OH groups, the greater the swelling produced.

As the polar molecules migrate into the plant fiber, the cellulose polymer chains are pushed apart from one another. When multiplied countless times, these molecules migrating between chains and throughout the fibrils and fibers result in the overall swelling of the structure. It is this macromolecular swelling that is readily observable with means such as the digital microscope in this study. When referring to relative scales in discussions of wood structure, Meier et al. (2005) define macromolecular as the scale at which the composition of the cell wall can be discussed, whereas microscopic refers to the scale of a whole cell, and macroscopic refers to the overall dimensions of the whole system.

However, when dealing with baskets, it must be noted that the cellulose is far from pure, and that factors such as species, cellular structure (tissue type), extractives, as well as the type of swelling media introduced are variables which complicate the swelling process.

Water

Water is one of the strongest swelling agents (besides strong alkalis which greatly disrupt and damage the cellulose structure), and is stronger than either ethanol or isopropanol, as shown in the table below. As previously mentioned, water's size and two active -OH groups are key to its swelling power as it can physically penetrate smaller spaces as well as form more hydrogen bonds not only to cellulose, but also to other water molecules. As a result, water has a higher surface tension (and cohesion to itself) than ethanol and isopropanol which is thought to enhanse the swelling effect (Banik, Brückle, and Daniels 2011; Mantanis, Young, and Rowell 1994; Kronkright 1990).

Ethanol

Ethanol, a solvent just over half as polar as water, is similar in that it forms hydrogen bonds with the cellulose polymers, allowing fibrils to slide along one another and producing flexibility. It does not swell wood as readily as water (as discussed above), and it has the potential to solubilize extractives. However, it can be considered more gentle due to its slower action (larger molecular size). Rate of swelling, though not specifically investigated in this study has been found to be important in how damaging swelling is to the cellulosic structure of plant tissues (Baker and Grattan 2011; G. I. Mantanis, Young, and Rowell 1995; Gilberg 1986; Kronkright 1990)

Aqueous binary mixtures

It has been observed (for example by Meier et al. (2006) and by Mantanis et al. (1994)) that aqueous binary mixtures – that is water mixed with another liquid, specifically in this study with ethanol – produces a larger degree of swelling than water or solvent alone. What seems to be happening is that by adding ethanol (or isopropyl as done by the Arizona State Museum[9]) to water, the cohesion of the water is reduced and it becomes less viscous, increasing its wetting ability. If the water is therefore able to more readily interact with the cellulosic system, then the action of the water and the solvent on the cellulose are combined. This is key to why binary mixtures are more powerful swelling agents than water or solvents alone (Meier et al. 2006; Meier, Kaps, and Kallavus 2005; Mantanis, Young, and Rowell 1994).

According to Mantanis et al. (1994) in "Swelling of Wood Part I. Swelling in Water", this phenomenon within 'binary liquid mixtures' is due to the "higher secedeability from the cohesion force in the mixture compared to the pure liquid. Thus the constituent has a greater chance to attack adsorption sites responsible for the swelling of wood than that expected in pure concentration", meaning, in a mixture, both water and ethanol have less cohesive attraction to the rest of the molecules of their own kind due to the other being in the way (water has greater cohesion than ethanol due to its two active -OH groups vs. the single active -OH group on the larger ethanol molecule), this allows both liquids to form more H-bonds with the available -OH groups on the cellulose chains, resulting in a larger degree of swelling than either would cause on its own.

Despite this, Meier et al. (2005) caution that the effects of binary solutions on the swelling of cellulose are not understood as well as the effects of individual solvents. They point out that, "studying of wood behavior in aqueous solutions of organic substances has been avoided. This might be explained by the fact that the effect of binary mixtures of organic

9 Isopropanol is favored at the Arizona State Museum, often being used alone, as it produces less swelling at a slower rate as well as anti-microbial properties.

substances in aqueous solutions is more complex than with water alone. … The results of studies have been up to the present contradictious even using the same experimental techniques".

Properties of Swelling Agents

Swelling agent	Polarity (relative to water)	Relative swelling	Molecular wight (g/mol)	Surface tension (dynes/cm)
Water (H_2O)	1.000	100	18.01528	73.00
Ethanol (C_2H_6O)	0.654	83	46.06844	22.75
Isopropanol (C_3H_8O)	0.546	45	60.09502	21.4
Binary aqueous solutions (H_2O+ ...)	Variable (dependent on proportions of the mixture)	> H_2O Though, while Mantanis et al. discuss how mixtures of organic solvents and water cause more swelling than either alone, they emphasize that the exact values have so far been difficult to measure. Meier et al. also discuss the difficulties encountered when investigating binary solutions.	Variable (dependent on proportions of the mixture)	Variable (though always between that of water and the added solvent)

1. Values reproduced from Solvents and Solvent Effects in Organic Chemistry, Wiley-VCH Publishers, 3rd ed., 2003
*2. Values compiled from (Mantanis and Young 1997) as well data on isopropanol from Dow Chemical (*http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_08ac/0901b803808aca73.pdf?filepath=oxysolvents/pdfs/noreg/327-00031.pdf&fromPage=GetDoc*)*
3. Relative swelling of plant material, labelled only as 'wood' reproduced from (Kronkright 1990) page 153. The values are relative to the swelling of wood in water, which is set to a value of 100.

5. Methodology and Materials

The experimental methodology for this study is summarized in the following steps:

- Sample preparation (cutting, mounting on frames and installing in custom chambers)
- Before-treatment photography of all fully prepared samples over a reference grid
- Imaging and measurements before treatment (measuring 5-10 times per spot using the Keyence VHX-1000 Digital Microscope at 100x – any higher magnification required so many images to be stitched together as to make the process impractical)

- Delivery of conditioning medium and sealing chambers (using a Dahlia Sprayer to deliver approximately 0.05mL of water and or ethanol and Latex 74 [Douglas and Sturgess] to seal the chambers)
- Digital microscope imaging and measurements of the samples in their sealed chambers after 24 hours of conditioning (RH monitored within the chamber with a HOBO UX100-023 data-logger with external probe)
- Recovery (samples were allowed to return to equilibrium [EMC] by opening the chambers and letting them sit for 24 hours undisturbed)
- Digital microscope imaging and measurements after recovery (RH monitored within the chamber with a HOBO UX100-023 data-logger with external probe)
- After treatment photography of samples over a reference grid

5.1 Plant types chosen for this study and sample sources

The number of plant types examined for this study was limited to three, and was further reduced to two during experimentation. Those chosen are members of types used widely in their representative regions and therefore also well represented in museum collections of basketry. They were also chosen specifically for differences in structural composition between softwood, hardwood and non-woody species. As the experiment progressed, the differences in the structural and chemical composition, between softwood and hardwood especially, became increasingly apparent and important.

Spruce (*Picea spp.*)

Spruce species are conifers (softwoods) native to North America and are used extensively, especially the roots, for basketry along the Northwest coast.

Basketry sample: Tlingit lidded basket, probably 19th century (Crawford 1986), donated to the UCLA/Getty program in 2015 after being deaccessioned from the San Diego Museum of Man (formerly object # 1900.018.0011 [or 1946.006.0092]). The basket is a close-Z-twined construction made of spruce root; the false embroidery decoration is probably maiden hair fern or dyed grass (Adovasio 1977)

Figure 1: Tlingit lidded basket, spruce root, circa 19th C.

Non-basketry sample: from UCLA/Getty conservation training lab reference collection. The material was gathered in Juneau, Alaska in 2007 by then UCLA/Getty conservation student Molly Gleeson and is described as 'split and prepared'. Gleeson worked under the guidance of Haida/Tlingit weaver Teri Rofkar, and co-authored a paper, *Collaborative Work Towards the Preservation of Spruce Root Basketry as a Living Tradition* (Gleeson et al. 2008).

Willow (*Salix spp.*)

Willow is a widespread hardwood, represented my many individual species. Various species (so many that willow is often simply identified as the general *Salix spp.* rather than by specific species (Anderson 2005)) were and are very commonly used as basketry materials and specifically in the Sierra Nevada of California.

Basketry sample: Paiute cradlebasket from central California, donated to the UCLA/Getty program in 2015 after being deaccessioned from the San Diego Museum of Man (formerly object # 1953.082.0109). This cradlebasket is an open-twined construction. Thicker, stronger warps make up the backboard while finer, more flexible warps made up the domed visor. The wefts are spaced out evenly, at intervals of about one inch. The samples were cut from the visor.

Figure 2: Paiute cradlebasket, willow. Note the incorrect placement of the cradle hood which has been reattached at the foot of the cradle rather than at the head. The history of this 'repair' is unknown.

Non-basketry sample: from UCLA/Getty conservation training lab reference collection. The material was gathered in Happy Camp, California in 2012, and was described as 'prepared'.

Juncus (*Juncus textilis*)

Juncus textilis, also known as basket rush, was intended to be the third species studied in this project. *Juncus textilis* is a species of rush or reed native to the coastal mountains of Southern California and has been used by many groups for basketry including by Chumash and Cahuilla weavers (Anderson 2005). It was, however, pulled from the study during the experimental phase due to the difficulty of imaging the samples well enough to measure accurately: the woven juncus was sampled from a basket which was woven with thick, whole, un-split stems. These rounded and thick stems (and the even thicker dimensions of the resulting basket wall and open weave) made both cutting and securing sample to the frames without loosing the weave extremely difficult. At the same time, imaging the samples accurately enough to measure (meaning producing a stitched image in which the entire area of interest is in focus), was nearly impossible because of the large number of images required (over 50) to overcome the large depth of field. The resulting rendering time and image size was impractical when considering how many fully stitched images and measurements would have to be produced.

Basketry samples: the basket used in this study was commissioned in the fall of 2016. The open-twined basket was woven from freshly gathered, un-split, juncus by Cahuilla weaver Rose Ann Hamilton near Palm Springs, California.

Figure 3: Basket made from fresh juncus by Cahuilla weaver Rose Ann Hamilton in 2017.

While the basket supplied for this study was woven from whole, fresh stems, Juncus is often also processed before weaving. Traditionally, it is gathered in the spring and the stalks split into three pieces of equal size and then subdivided. The prepared strands are dried and not used for several months. When ready for use, the dried strands are soaked in water to make them soft and pliable again (Pearlstein et al. 2008).

Non-basketry sample: from UCLA/Getty lab reference collection, no information was provided as to its age or processing, the stems were long and whole, suggesting they had simply been dried.

Processing

The various types of plant materials used in the creation of basketry were often modified before being used for weaving. While some plant elements were woven fresh (such as the juncus in this study), plant materials were most often were further modified, or processed following gathering (Norton 1990). This processing involved steps such as stripping, splitting, and trimming to improve the shape or uniformity of the fibers and drying and seasoning for an extended period of time to prevent uneven shrinkage of fibers gathered at different times once woven into one basket (Bates and Lee 1990). Only when ready for immediate use were stored fibers rendered supple again by soaking in water.

It is therefore reasonable to conclude that the woven willow and spruce root in this study have been both dried and soaked during the original processing and preparation of the fibers (as mentioned above, the juncus was woven fresh). Whether this previous exposure to deliberate drying and immersion have an impact on the response of these fibers during the controlled humidification/conditioning study cannot be definitively determined here. However, it may be possible to glean clues from the comparison of the woven and non-woven (minimally processed) samples. The processing of spruce root such as that used to weave the basket in this study would most likely have consisted of the following steps. Gathering of roots (particularly long, straight ones growing unobstructed by rocks or other roots) in the early spring, roasting and stripping free of bark, splitting into long strands (Gleeson et al. 2008; Schaffer 1976).

5.2 Design & construction of humidification chambers

In order to image and measure the swelling behavior of the samples before and during conditioning, as well as after recovery, conditioning chambers were designed in which samples could be housed for the duration of the experiment without being removed. Additional criteria included that the chambers be portable, be able to accommodate a data-logger to record RH, be able to fit on the stage of the digital microscope beneath the objective without being opened, to be optically clear enough to image the sample through the chamber lid, and most importantly, be able to maintain an RH of approximately 70% over 24 hours without leaking or forming condensation.

For the construction of the miniature chambers, various materials and readily available plastic boxes were tested, resulting in the following design made up of a selection of easily sourced components.

Chamber

AMAC Plastic M Series boxes # 522C

(http://www.amacpackaging.com/products/mseries/index.html)

Polystyrene

2 × 2 × 0.75 inches (5.08 × 5.08 × 1.90 cm)

Water/solvent delivery system

2 × 2 inches (5.08 × 5.08 cm) blotter paper

300cc Dahlia Sprayer

Box sealants

Latex 74 (Douglas & Sturgess)

Sticky Wax No. 09-100 (Benchmark)

Sample mounts

4mm Coroplast® cut into ‘frames’ or mounts to prevent samples from directly touching the blotter with mercerized cotton thread for mounting samples to Coroplast® mounts

Data-logger and software

Onset HOBO UX100-023 with external probe

HOBOware 3.7.8 software from Onset Computer

The chamber

The only modification required on the AMAC Plastic M Series boxes was the creation of a roughly 1×1.5 cm port through which the data-logger probe could be inserted. This port was drilled through the side of each box with a Dremel tool using a #125 high speed cutting bit. A high speed bit is necessary in order to successfully drill plastic as ordinary wood-drilling bits catch on the plastic and cause it to shatter. The high speed bits have a sharp point and produce enough heat to soften the plastic, allowing the bit to sink into the material without catching and snapping it. The edges of the drilled ports were then filed smooth.

The HOBO UX100-023 probe with its original protective probe cover had a diameter of 0.4 inches (1.02 cm) which would have required a port which would have been too large for the side of the box (interfering with the lid). Removing the protective cover revealed the chip component of the probe which was much smaller and allowed for a much smaller port.

Water/solvent delivery system

A 2 by 2 inch (5.08 by 5.08 cm) square of blotter paper was cut for each chamber. A Dahlia Sprayer, which is capable of producing a very fine and even mist, was used to deliver the conditioning liquids. Because the chambers were so small, a very small amount of water quickly caused the internal RH to reach saturation. The optimal amount of water to bring the chamber to approximately 70-80% RH was determined to be about 0.05mL or one back-and-forth spray with the Dahlia Sprayer at a distance of about 5-6 inches (or between roughly 13 and 15 cm).

Water-vapor impermeable seal for chamber

Various materials were tested in order to make the chambers vapor impermeable. The best and easiest material to use was Latex 74, a heavy paste, air-drying, natural rubber latex from Douglas and Sturgess which was applied by brush in a line to seal the join between the box and lid. It was also used to seal the open port on the side of the box by painting a thick layer over a small rectangle of blue painters tape secured over the hole. The latex sets after drying for approximately 10 minutes.

When the port was in use, Sticky Wax No. 09-100 was a quick and effective solution for sealing the gap around the measurement head of the logger placed in the port.

Materials Tested for Sealing Data-logger Port

Sealant material tested	Ease of use/application	Successful over 24h period?
Latex 74 (Douglas and Sturgess)	Easy to spread the paste over all areas needing sealing. In order to bridge larger areas, ie. the empty data-logger port, a small piece of blue tape was applied over the port and then fully covered with the latex. Maintained excellent contact with the polystyrene of the box AND the plastic shaft of the data-logger probe. Air dried within 10 minutes, very easy to peel away when done.	**Yes**
Sticky Wax No. 09-100 (Benchmark)	Worked well to seal the seam between box and lid as well as the port, even with the probe in place. Sticky Wax was very messy and difficult to work with, coating hands and gloves and leaving smears on the plastic box that require cleanup with ethanol. Most convenient for sealing the gap around the probe in the port when the data-logger is in place.	**Yes**
Parafilm®	Easy to manipulate and press into tight spaces (ie. between box and lid), but very difficult to secure in place around port as it has no adhesion of its own.	No (leak at port)
Groom/Stick	Easy to manipulate, but did not stick well to either the plastic of the box or the plastic shaft of the data-logger.	No (leaks at all joins)

Sample mount

A mounting system was designed to both keep the samples from shifting in the chambers as well as to prevent them from touching the damp blotter paper and absorbing excess water.

The solution was a 'frame' cut from Coroplast® which could be easily inserted or removed from the chamber with a pair of tweezers. The samples were secured to this frame with mercerized cotton thread. Care was taken not to place strain on the sample by tying it to the frame too firmly. To allow space for the data-logger probe, the frames were cut with a notch at the top-right corner.

Final setup

The diagram below shows the construction of a chamber.

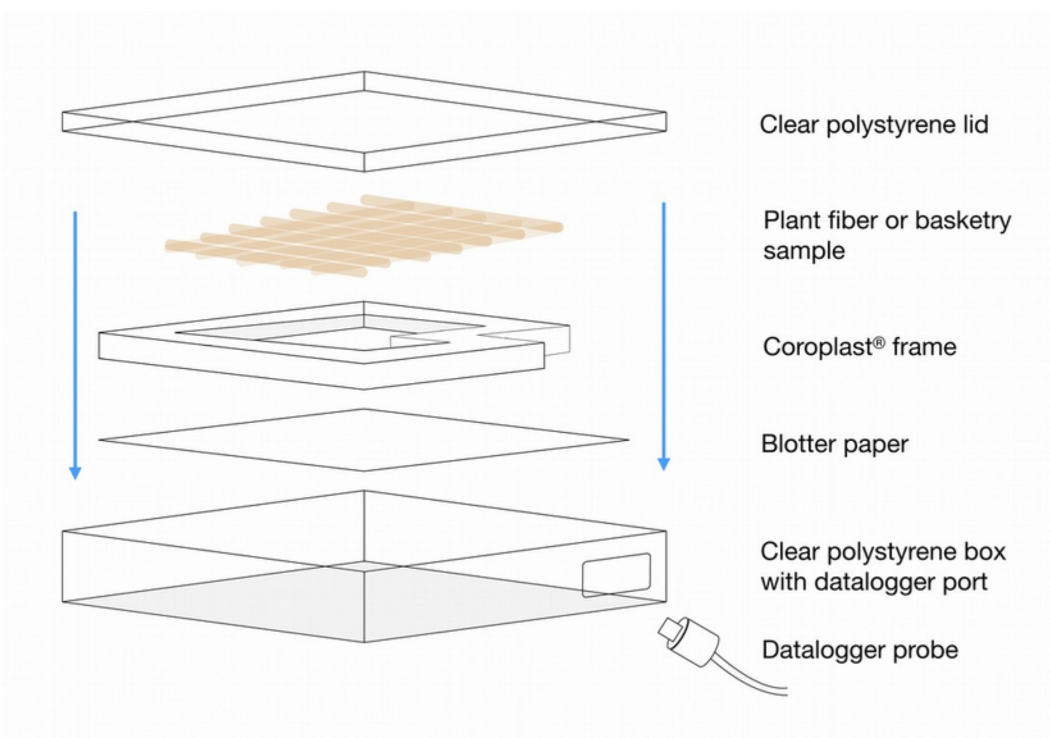


Figure 4: Construction of the custom experimental chambers.

5.3 Sampling

As mentioned above, samples were prepared from baskets as well as non-basketry material representing spruce, willow and juncus.

Preparing samples

In order to measure changes over a large number of stitches in each trial, each sample had to be large enough to provide as many measurement points as possible, with the maximum possible dimensions being limited by the 2 × 2 inch (5.08 × 5.08 cm) dimensions of the humidification chambers. Cross sections were also prepared for each sample. Care was taken to document the areas as they were sampled – and once the study was finished, all samples were re-housed with the baskets of origin.

Mounting samples

Each basketry sample was gently tied to the frame with mercerized cotton thread and each sample cross section was mounted by cutting a small round hole in the top layer of the Coroplast® which allowed the cross section to be inserted without touching the blotter.

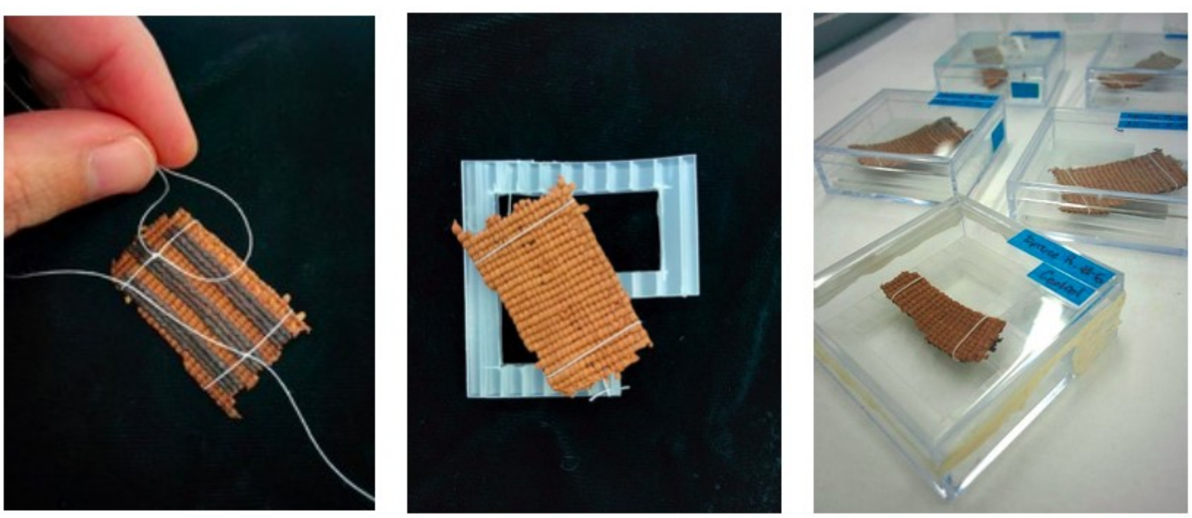


Figure 5: The process of mounting basketry samples. The sample was secured to the Coroplast® frame using mercerized cotton thread, the corner cut from the frame provides room for the data-logger probe once the frame is placed into the mini chamber.

Throughout the study, a total of 54 samples were prepared, including basketry, non-basketry and cross-sections of each (excluding the discarded juncus samples). The following chart shows the sample sets and their corresponding treatments during the experimentation phase.

Basket fiber species	**Chamber**	**Conditioning media**
Spruce root *(Picea spp.)*	1 *(Basketry sample) + 1 cross section*	Control *(no added medium)*
	2 *(Basketry sample) + 1 cross section*	DI water
	3 *(Basketry sample) + 1 cross section*	EtOH
	4 *(Basketry sample) + 1 cross section*	70:30 DI water and EtOH
	5 *(Basketry sample) + 1 cross section*	30:70 DI water and EtOH
	6 *(Basketry sample) + 1 cross section*	50:50 DI water and EtOH
	7 (*Non-basketry sample) + 1 cross section*	Control
	8 (*Non-basketry sample) + 1 cross section*	DI water
	9 (*Non-basketry sample) + 1 cross section*	EtOH
Willow *(Salix spp.)*	1 *(Basketry sample) + 3 cross sections*	Control *(no added medium)*
	2 *(Basketry sample) + 3 cross sections*	DI water
	3 *(Basketry sample) + 3 cross sections*	EtOH
	4 *(Basketry sample) + 3 cross sections*	70:30 DI water and EtOH
	5 *(Basketry sample) + 3 cross sections*	30:70 DI water and EtOH
	6 *(Basketry sample) + 3 cross sections*	50:50 DI water and EtOH
	7 (*Non-basketry sample) + 3 cross sections*	Control
	8 (*Non-basketry sample) + 3 cross sections*	DI water
	9 (*Non-basketry sample) + 3 cross sections*	EtOH
Juncus *(Juncus textilis)*	1 *(Basketry sample)*	Control
	2 *(Basketry sample)*	DI water
	3 *(Basketry sample)*	EtOH
	4 *(Basketry sample)*	70:30 DI water and EtOH
(Removed from study)	5 *(Basketry sample)*	30:70 DI water and EtOH
	6 *(Basketry sample)*	50:50 DI water and EtOH
	7 (*Non-basketry sample)*	Control
	8 (*Non-basketry sample)*	DI water
	9 (*Non-basketry sample)*	EtOH

5.3 Imaging and measurements with the Keyence VHX-1000 Digital Microscope

Image stitching

In order to measure the widths of stitches, still images were taken with the digital microscope by stitching together series of images. Because of the loss of focus resulting from the depth of field achieved at the magnification (100x), between 12 and 25 images were taken at vertical increments of 50µm.

In addition to the vertical stitching, the basketry sample images were stitched horizontally into patchwork of up to 8 or 10 images each containing 12-25 vertical images. To account for the shallow depth of field of the microscope, stacks of images were captured in each mosaic tile to produce a final flattened image in complete focus. An average of 12-25 images were required for each vertical stack. As a result, each composite image could contain up to 200 individual captures.

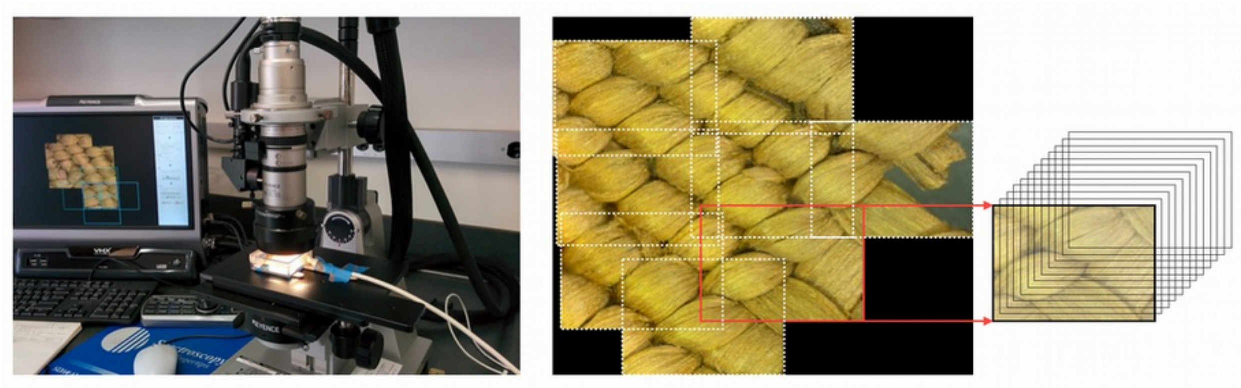


Figure 6: Left, a chamber in place on the digital microscope. The chamber fits beneath the objective and allows the sample to be imaged without opening the chamber and disrupting the microclimate. The data-logger probe is sealed in place with Sticky Wax and is attached to the logger via the white cable. Right, the processes of stitching a final composite image of a spruce root basketry sample. The area encompassed in the final image allows for the measurement of multiple stitches from one image.

The resulting composite was then flattened into one, fully in focus image from which measurements could be easily taken.

Measurements

Locations were measured before, during and after conditioning using the Keyence VHX-1000 Digital Microscope software. The software allows for the operator to manually measure by clicking and dragging a measuring tool from one point to another.

Points were chosen on samples based on visual landmarks on the topography of the samples which could be easily relocated over and over. The measurements then had to be taken manually. For the earlier sets, 5 measurements were taken per spot, for later sets the number was increased to 10 per spot to increase the amount of collected data.

For each sample, the measurements were as follows:

Sample	Elements per sample	Spots per element	Measurements per spot	Repetitions
Willow basketry (W-B)	1 basketry sample	5 (stitches)	5	

	3 warp cross sections	1 (diameter of each)	10	Each measurement set completed three times: Before and during conditioning as well as after recovery
Willow non-basketry (W-NB)	1 non-basketry sample	5	10	
	3 cross sections	1	10	
Spruce root basketry samples (SR-B)	1 basketry sample	10	5	
	1 basketry cross section	4	10	
Spruce root non-basketry samples (SR-NB)	1 non-basketry sample	5	10	
	1 cross section	3 (radii)	10	

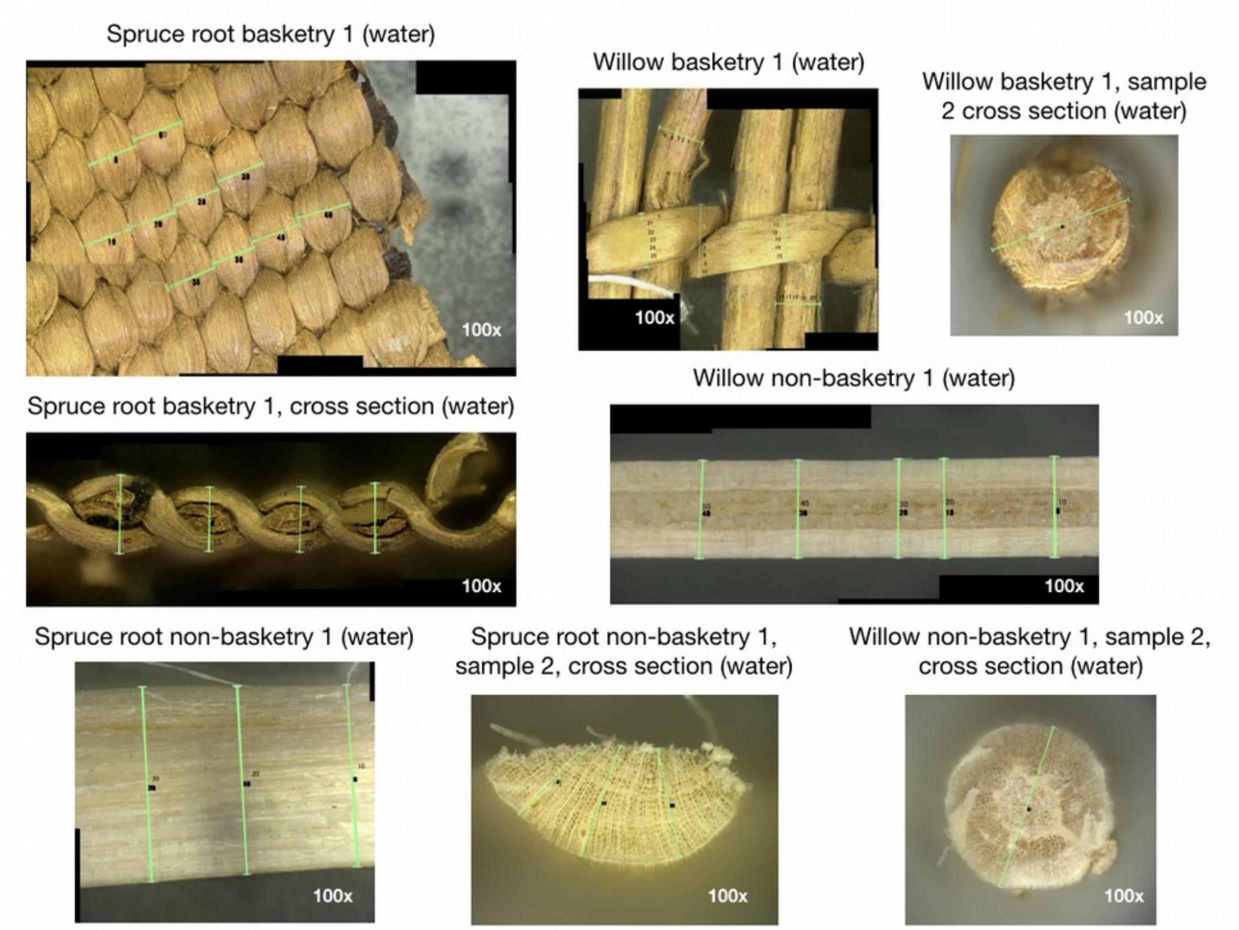


Figure 7: Examples of stitched composite images used for measurement of samples. Represented here are the water vapor-treated samples of each sample set, both basketry and non-basketry as well as horizontal as well as cross sectional samples.

Data analysis

Once all the measurements were collected, the data was processed as follows:

- For each spot the average width was found for before, during and after treatment.
- From these average widths, the percent change was calculated for each spot.
- The percent change for all spots on a sample were averaged to find the average percent change over the whole sample.
- Standard deviation and relative standard deviation (expressed as a percentage) was used to calculate the error in each individual spot measurement.
    - The error calculations produced some interesting results of their own which will be discussed below. Two main observations were that, firstly, measurements of cross sections seemed to be more accurate than the widths of stitches, and secondly, that operator accuracy decreased over time, with the measurements taken at the end of the longest runs (after 4-5 hours) showing the largest deviation.

The full compilation of data tables is available in the appendix of this document. The following table is an example of one of the data-sets and the numbers calculated from the measurements:

Spruce root 2, non-basketry (SR-NB), H2O, Before treatment

Spot on sample	Title	Measurement Result		
	Date saved	5/10/2017	2:03 PM	
	No.	Measure	Result	Unit
	1	2 Points	2925.3	µm
	2	2 Points	2929.66	µm
	3	2 Points	2925.26	µm
	4	2 Points	2933.85	µm
	5	2 Points	2933.71	µm
	6	2 Points	2933.86	µm
Spot # 1	7	2 Points	2933.8	µm
	8	2 Points	2929.94	µm
	9	2 Points	2929.63	µm
	10	2 Points	2935.99	µm
		Average (mean)	2931.10	
		Standard Deviation (σ)	3.75	
		% Relative Standard Deviation (%RSD)	0.13	
	11	2 Points	2857.26	µm
	12	2 Points	2853.01	µm
	13	2 Points	2857.35	µm
	14	2 Points	2855.18	µm
	15	2 Points	2857.35	µm
	16	2 Points	2855.21	µm
Spot # 2	17	2 Points	2859.46	µm
	18	2 Points	2853.01	µm
	19	2 Points	2855.13	µm
	20	2 Points	2859.43	µm
		Average (mean)	2856.24	
		Standard Deviation (σ)	2.32	
		% Relative Standard Deviation (%RSD)	0.08	
	21	2 Points	2833.92	µm
	22	2 Points	2850.89	µm
	23	2 Points	2838.29	µm
	24	2 Points	2846.63	µm
	25	2 Points	2838.22	µm
	26	2 Points	2840.27	µm
Spot # 3	27	2 Points	2844.57	µm
	28	2 Points	2846.61	µm
	29	2 Points	2831.8	µm
	30	2 Points	2842.42	µm
		Average (mean)	2841.36	
		Standard Deviation (σ)	6.01	
		% Relative Standard Deviation (%RSD)	0.21	
	31	2 Points	2844.87	µm
	32	2 Points	2852.75	µm
	33	2 Points	2839.16	µm
	34	2 Points	2847.38	µm
	35	2 Points	2853.62	µm
	36	2 Points	2847.84	µm
Spot # 4	37	2 Points	2862.12	µm
	38	2 Points	2851.5	µm
	39	2 Points	2855.93	µm
	40	2 Points	2846.95	µm
		Average (mean)	2850.21	
		Standard Deviation (σ)	6.40	
		% Relative Standard Deviation (%RSD)	0.22	
	41	2 Points	2798.98	µm
	42	2 Points	2794.26	µm
	43	2 Points	2792.22	µm
	44	2 Points	2803.56	µm
	45	2 Points	2794.99	µm
	46	2 Points	2802.45	µm
Spot # 5	47	2 Points	2796.18	µm
	48	2 Points	2796.84	µm
	49	2 Points	2773.55	µm
	50	2 Points	2800.78	µm
		Average (mean)	2795.38	
		Standard Deviation (σ)	8.50	
		% Relative Standard Deviation (%RSD)	0.30	

Spruce root 2, non-basketry (SR-NB), H2O, During humidification

Title	Measurement Result		
Date saved	5/16/2017	3:39 PM	
No.	Measure	Result	Unit
1	2 Points	2855.76	µm
2	2 Points	2861.74	µm
3	2 Points	2849.3	µm
4	2 Points	2859.83	µm
5	2 Points	2865.67	µm
6	2 Points	2855.1	µm
7	2 Points	2847.09	µm
8	2 Points	2855.54	µm
9	2 Points	2848.68	µm
10	2 Points	2855.06	µm
	Average (mean)	2855.38	
	Standard Deviation (σ)	5.94	
	% Relative Standard Deviation (%RSD)	0.21	
11	2 Points	2801.97	µm
12	2 Points	2808.34	µm
13	2 Points	2816.9	µm
14	2 Points	2823.2	µm
15	2 Points	2810.58	µm
16	2 Points	2812.58	µm
17	2 Points	2802.12	µm
18	2 Points	2808.6	µm
19	2 Points	2806.35	µm
20	2 Points	2802.26	µm
	Average (mean)	2809.29	
	Standard Deviation (σ)	6.90	
	% Relative Standard Deviation (%RSD)	0.25	
21	2 Points	2861.74	µm
22	2 Points	2874.78	µm
23	2 Points	2876.66	µm
24	2 Points	2870.09	µm
25	2 Points	2872.08	µm
26	2 Points	2885.27	µm
27	2 Points	2863.77	µm
28	2 Points	2881.66	µm
29	2 Points	2870.07	µm
30	2 Points	2881.6	µm
	Average (mean)	2873.77	
	Standard Deviation (σ)	7.75	
	% Relative Standard Deviation (%RSD)	0.27	
31	2 Points	2803.74	µm
32	2 Points	2810.76	µm
33	2 Points	2809.26	µm
34	2 Points	2793.7	µm
35	2 Points	2816.79	µm
36	2 Points	2809.1	µm
37	2 Points	2806.43	µm
38	2 Points	2814.75	µm
39	2 Points	2810.85	µm
40	2 Points	2816.87	µm
	Average (mean)	2809.23	
	Standard Deviation (σ)	6.91	
	% Relative Standard Deviation (%RSD)	0.25	
41	2 Points	2789.65	µm
42	2 Points	2822.98	µm
43	2 Points	2811.32	µm
44	2 Points	2806.43	µm
45	2 Points	2815.96	µm
46	2 Points	2806.85	µm
47	2 Points	2792.96	µm
48	2 Points	2796.47	µm
49	2 Points	2806.6	µm
50	2 Points	2815.18	µm
	Average (mean)	2806.44	
	Standard Deviation (σ)	10.69	
	% Relative Standard Deviation (%RSD)	0.38	

Spruce root 2, non-basketry (SR-NB), H2O After recovery

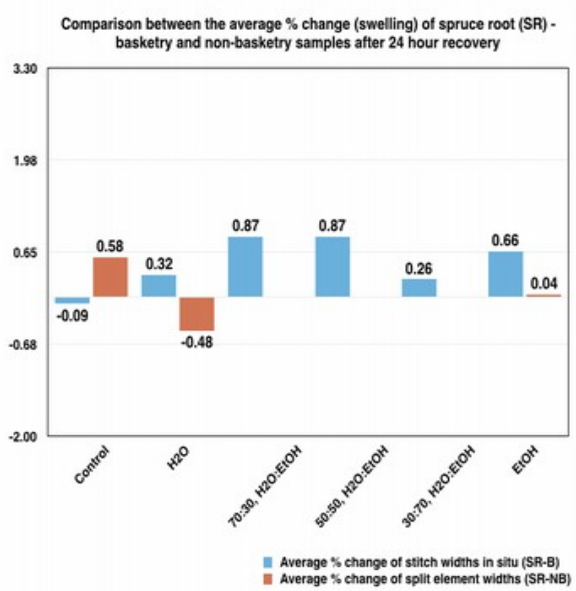
Title	Measurement Result			
Date saved	5/18/2017	2:52 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	2845.67	µm	
2	2 Points	2845.45	µm	
3	2 Points	2850.11	µm	
4	2 Points	2847.86	µm	
5	2 Points	2850.11	µm	
6	2 Points	2841.2	µm	
7	2 Points	2853.37	µm	
8	2 Points	2841.25	µm	
9	2 Points	2845.34	µm	
10	2 Points	2845.61	µm	
	Average (mean)	2846.60		-2.88
	Standard Deviation (σ)	3.87		
	% Relative Standard Deviation (%RSD)	0.14		
11	2 Points	2794.02	µm	
12	2 Points	2798.39	µm	
13	2 Points	2798.39	µm	
14	2 Points	2800.52	µm	
15	2 Points	2795.97	µm	
16	2 Points	2802.41	µm	
17	2 Points	2794.28	µm	
18	2 Points	2796.31	µm	
19	2 Points	2800.36	µm	
20	2 Points	2800.32	µm	
	Average (mean)	2798.10		-2.04
	Standard Deviation (σ)	2.86		
	% Relative Standard Deviation (%RSD)	0.10		
21	2 Points	2842.41	µm	
22	2 Points	2833.92	µm	
23	2 Points	2842.45	µm	
24	2 Points	2831.83	µm	
25	2 Points	2840.32	µm	
26	2 Points	2825.53	µm	
27	2 Points	2832.04	µm	
28	2 Points	2846.65	µm	
29	2 Points	2840.29	µm	
30	2 Points	2842.41	µm	
	Average (mean)	2837.79		-0.13
	Standard Deviation (σ)	6.58		
	% Relative Standard Deviation (%RSD)	0.23		
31	2 Points	2861.65	µm	
32	2 Points	2863.82	µm	
33	2 Points	2870.09	µm	
34	2 Points	2861.63	µm	
35	2 Points	2874.55	µm	
36	2 Points	2878.62	µm	
37	2 Points	2868.01	µm	
38	2 Points	2867.92	µm	
39	2 Points	2876.39	µm	
40	2 Points	2870.08	µm	
	Average (mean)	2869.28		0.67
	Standard Deviation (σ)	5.93		
	% Relative Standard Deviation (%RSD)	0.21		
41	2 Points	2857.45	µm	
42	2 Points	2829.7	µm	
43	2 Points	2853.25	µm	
44	2 Points	2850.98	µm	
45	2 Points	2857.34	µm	
46	2 Points	2855.15	µm	
47	2 Points	2857.43	µm	
48	2 Points	2848.91	µm	
49	2 Points	2851.02	µm	
50	2 Points	2850.94	µm	
	Average (mean)	2851.22		2.00
	Standard Deviation (σ)	8.19		
	% Relative Standard Deviation (%RSD)	0.29		
	Average % change			-0.48

6. Results

After measuring samples before, during and after conditioning, the accumulated data was analyzed and the results reflect trends described in the literature by conservators, forestry and material scientists such as Odegaard, Gilberg, Kronkright, Norton, Florian, Mantanis et al., Meier et al., Kránitz et al. and others. The following table displays the final results for dimensional change in two graphs, the first showing the data for spruce root and the second for willow.

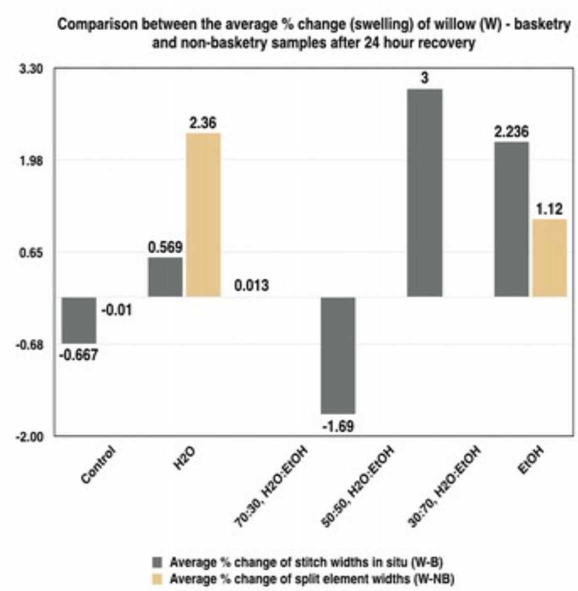
Spruce Root
Softwood

Spruce Root Sample	Average % change of stitch widths in situ (SR-B)	Spruce Root Sample	Average % change of split element widths (SR-NB)
Control	-0.09	SR-LP (control)	0.58
H_2O	0.32	SR-LP (H_2O)	-0.48
70:30, H_2O:EtOH	0.87		
50:50, H_2O:EtOH	0.87		
30:70, H_2O:EtOH	0.26		
EtOH	0.66	SR-LP (EtOH)	0.04



Willow
Hardwood

Willow Sample	Average % change of stitch widths in situ (W-B)	Willow sample	Average % change of split element widths (W-NB)
Control	-0.67	W-NB (control)	-0.01
H_2O	0.57	W-NB (H_2O)	2.36
70:30, H_2O:EtOH	0.01		
50:50, H_2O:EtOH	-1.69		
30:70, H_2O:EtOH	3.00		
EtOH	2.24	W-NB (EtOH)	1.12



The processed data reflected in these graphs specifically reflects the following observations:

1. That the samples were extremely sensitive to fluctuations in RH, and that there is evidence that several times the chamber seals were breached causing excessive drying and shrinking – I n particular the willow 50:50 sample, which was expected to have displayed magnified swelling due to binary effect. This sensitivity to RH proved especially important in the dry weather in Los Angeles and inside the lab, the environment of which largely reflected the outside conditions.

2. That most samples did not fully 'recover' their original dimensions. Out of eighteen sample sets, nine displayed net swelling over 0.5% at the time of final measurement. This behavior was distributed across all four sample types (spruce root and willow, both basketry and non-basketry samples). This may suggest that either the allotted recovery time of 24 hours (or just over) was not sufficient to facilitate full recovery to the equilibrium moisture content (EMC), that the RH of the ambient conditions had risen enough to increase the EMC for most samples (ie. if it had rained before final measurements were taken, some samples might have responded by taking up the extra moisture during the 24 hours allotted for recovery), or that swelling, once induced, does not necessarily recover fully at all.

3. That binary mixtures of water and ethanol do indeed produce a magnified swelling effect. This is crucially important in the context of conservation as ethanol is often added to otherwise aqueous treatments as an anti-microbial agent, but not necessarily to intentionally induce this magnified binary effect. An awareness of this phenomenon is important when attempting to condition materials, particularly if they are already in poor condition.

4. That spruce had a smaller overall percent dimensional change than willow: this is supported in the literature which shows that softwoods (such as spruce) swell to a lesser degree than hardwoods (such as willow). Several factors are believed to be at play, most importantly, the larger concentrations of hydrophobic extractives and lignin, which prevent the infiltration of water or other polar molecules (Mantanis and Young 1997; Kronkright 1990).

The marked differences in the properties of these two types of wood which have been well documented by other researchers are also clearly apparent in this study. Taking note of the species present (and whether the tissues present are softwood, hardwood, or non-woody) could be very important for the outcome of conditioning treatments of basketry, and treatment protocols can be modified accordingly. For example, because of the lesser capacity for swelling of extractive and lignin rich softwood, the greater swelling potential of water might in fact be useful, whereas, when slower, lesser swelling is desired, less polar solvents such as ethanol could prove better.

While outside the scope of this study, the answer the to question of whether extractives are stripped from wood by solvents such as ethanol and isopropanol seems to be that when used in the vapor phase (as is done in vapor chamber conditioning), these solvents do not flood the system to an extent which causes detrimental migration of the soluble compounds, and can be considered safe for the basket when used in this way.

5. And finally, that although physical condition of the wood most likely plays a role in the extent of dimensional change, clear indication of this were not captures in the data of this study despite the apparently great difference in condition between the basketry and non-basketry spruce root samples shown in SEM images.

As mentioned previously, age does not necessarily correlate with deterioration. Aged wood can be very stable, and chemically speaking more inert to the influence of moisture than younger wood due to a progressive increase in crystalinity. Plant tissues loose their amorphous regions over time as the spacial reorientation of mechanosorptive creep rearranges the -OH bonds, forming more permanent, more crystalline, connections which cannot be as easily interrupted (Kronkright 1990). Kránitz also refers to this when describing the 'stabilization' of 300 year old wooden beams (Kránitz et al. 2016).

Kránitz et al. (2016), cautions that available data on the behavior of aged wood is difficult to condense into useful overreaching trends – partly due to the large number of variables which can affect the hydroscopicity of wood. For example, while Kránitz et al. (2016) cite a study in which aged spruce wood was observed to swell more due to a natural increase in density as internal structures alter chemically (ie. the increased crystallization of formerly amorphous cellulose), Kronkright, on the other hand, wrote in 1990 that aged wood should be expected to swell less due to the deterioration of the physical structure of wood and the loss of -OH sites available to interact with polar molecules (Kronkright 1990)[10]. This is also echoed by R. D. Buck who wrote in 1952 that aged or rather 'seasoned' wood becomes more immune to the swelling influences of water (Buck 1952). Again, this is clearly referring to sound, otherwise un-deteriorated wood which has not undergone chemical changes beyond those which naturally

10 In describing the decreased moisture regain of plant materials which have undergone mechanosorptive creep, Kronkright writes: "Changing humidities do more than change materials volumetrically and cause distortions. Each change in relative humidity results in three significant changes to the material in addition to those we have just considered. The first result is that, increasingly, sites along amorphous regions available for hydrogen bonding with water will be taken with new, more closely oriented hydrogen bonding between cellulose polymer aggregates. This takes place at many levels of organization wherever water molecules could once penetrate: amorphous regions between the crystalline micelles, between cellulose aggregates in the microfibrils, between microfibrils within the fibrils, and between the fibrils within the cell wall. The net result is that the quantity of water molecules taken into amorphous regions following a previous desorption and subsequent mechanosorptive creep is decreased. We say that the moisture regain of the material has decreased. A decrease in moisture regain means that there are fewer available sites, and consequently fewer gel amorphous regions between crystalline areas to allow flexibility, compression, tension, and elasticity (Kronkright 1990, 149-150).

occur to cellulose over time without the influence of microbes or other external agents of decomposition.

Again, the key difference here is that Kronkright and Buck, unlike Kránitz et al., are specifically describing aged but sound wood, whose tissues have undergone the chemical changes associated with aging which reduce the swelling potential rather than wood which has been severely chemically and structurally damaged, for example by fungal or bacterial deterioration. In these cases, the whole structure of the wood is disrupted in ways which, rather than 'condensing' the cellulosic structure and reducing not only the space in which adsorption of polar molecules can take place but also the number of available bonding sites, actually tears apart the micro-structure, leaving, so to speak, ragged edges with lots of possible bonding sites for polar molecules to adsorb, bind, and therefore swell the tissue.

7. Limitations

Unexpected results such as unusual shrinkage of samples suggest possible experimental or methodological sources of error, in particular:

Failed chamber seals: instances of unexpected shrinkage, particularly the willow basketry (WB) 50:50 (which was expected to have resulted in magnified swelling due to the binary effect), are most likely due to a breach in the liquid latex seal. The relative humidity in the laboratory spaces was nearly always lower than the humidification range of 70-80% RH – indeed museum spaces are often held at a standard 50% RH, though as the chart below shows, the conditions in the lab were much more variable and in fact directly relate to weather conditions outside. The difference in RH between the ambient lab conditions and the inside environments of the chambers was such that if a seal were to fail, the vapor inside would escape into the atmosphere with the lower RH, and a loss of either water or ethanol from the physical structure of a sample causes measurable shrinkage.

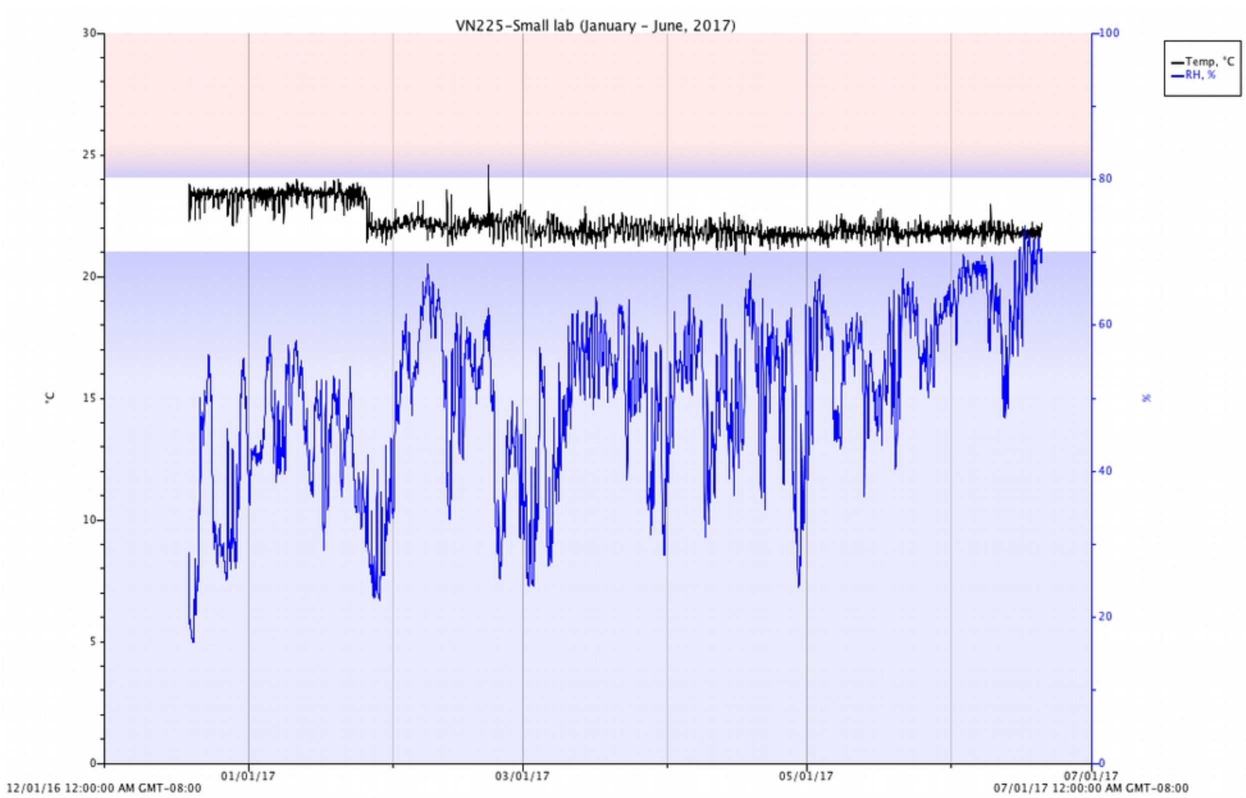


Figure 8: Onset Hobo data output showing the conditions in the Getty Villa training lab VN225 over the span of January - June 2017, the time during which the experiments for this project were undertaken. While the relative humidity (in blue) fluctuates greatly in conjunction with the outside weather conditions (drops into the 30% RH range are Santa Ana wind storms), the values also almost never reach the humidification range of 70-80% RH (marked by the white horizontal stripe). The result of this is that a sample humidified to 70-80% RH will dry out if it is exposed to the ambient conditions of the lab, and this loss of water and or ethanol directly leads to shrinkage.

Santa Ana windstorms are an annual group of weather events unique to Los Angeles. The hot and dry air blows over the city from the desert to the east and the effect on relative humidity is dramatic. The data in the graph below was captured on April 26, 2017 and shows a RH drop from approximately 60% down to 30% in just four hours (with the steepest drop in the first two hours). Fast transitions like these are exactly the kinds of fluctuations to be avoided when caring for cellulosic materials.

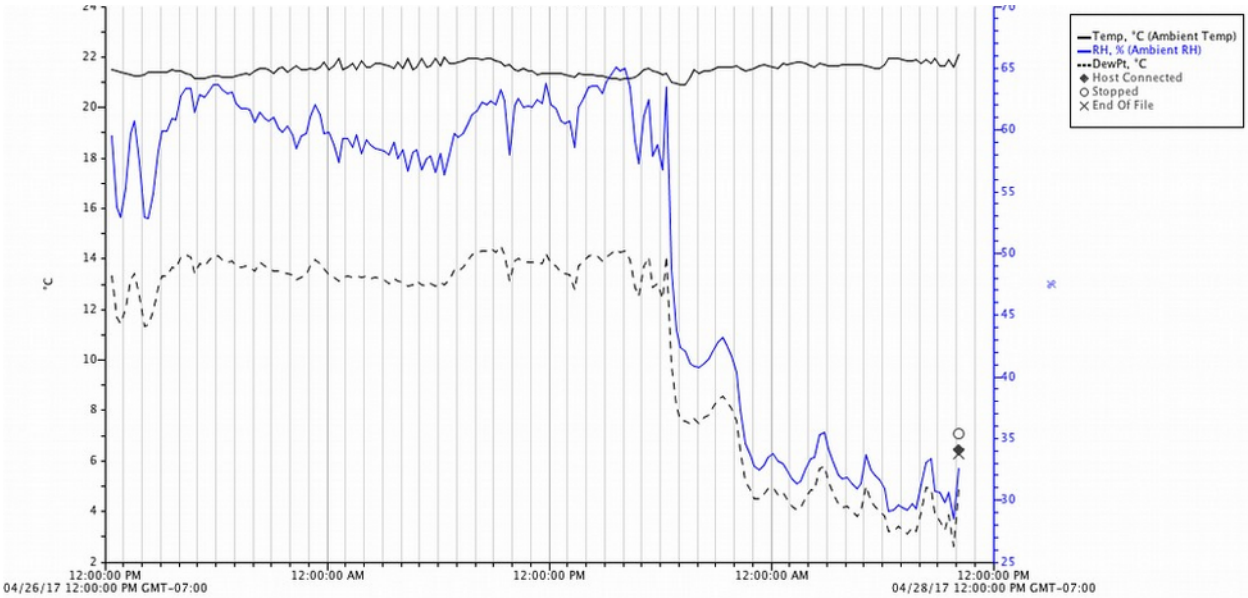


Figure 9: This Onset Hobo data output from the Getty Villa training lab VN225 on April 26, 2017 shows the fast and steep overnight drop in RH during a Santa Ana windstorm in Los Angeles. Of particular importance to this study is the fact that this is a drop in RH inside the lab, and that such extreme fluctuations are bound to have an effect on sensitive materials.

It is widely recognized that plant materials such as wood are highly responsive to ambient conditions, swelling as the surrounding air cools and looses capacity to hold moisture and shrinking as the air warms and increases its moisture-holding capacity. This is most recognizable, Kronkright points out, in the sensitivity of panel paintings and varnished wooden furniture (Kronkright 1990). That basketry fibers are just as sensitive raises serious questions about how responsive the samples in this study might be at any time the chambers were opened or if the seals were breached – for example, any environmental fluctuations during the recovery time. For this reason additional data-logger information from the laboratory loggers was gathered for cross referencing incase of other anomalies.

Volume of data and statistical significance: In studies such as this in which samples are taken from items of cultural heritage, it is often the case that the data sets are small, leading to difficulties in extracting statistically significant results.

Digital microscopy, photography and SEM: Of the techniques employed in this study, collecting measurements with the digital microscope was by far the most effective technique of collecting quantitative data on the swelling behavior of the samples. The measurements gathered allowed for the compiling of data before, during and after conditioning. The data was then easy to render into graphs which allow easy visualization of the swelling and shrinking experienced by each sample. Specific drawbacks experienced were limited to the time-consuming nature of data collection – and the limits operator fatigue placed upon the accuracy of data points collected during long stretches at the machine as well as the difficulty of imaging (and therefore accurately measuring) samples with a very rounded profile (such as the *Juncus textilis*). This is a problem which is particularity relevant as not all basketry materials are prepared by splitting or otherwise flattened from their natural shape before weaving.

In contrast neither conventional photography nor examination with the scanning electron microscope produced such results. The changes to the dimensions of the samples during swelling and shrinking were too small to be captured with the digital camera, even with the addition of a reference grid – it was impossible to know that the grid was in the exact same placement with each photograph. Several of the samples themselves were also loose enough in their mounts to shift slightly during transportation around the lab which likewise made photography a less accurate tracking method.

Scanning electron microscopy imaging also did not produce the desired results. Several samples were chosen for examination from the basketry and non-basketry spruce root sample sets. While no meaningful differences were detected between the controls and the treated samples, what was immediately obvious was the severe degree of deterioration of the basketry spruce root sample (from the Tlingit basket) as compared to the gathered and processed but un-woven spruce root sample. Without knowing the complete history of this basket, it is impossible to know in what conditions it was used or stored. Given that this type of lidded basket was not traditional but rather was made for the tourist market (Crawford 1986), the assumption then must be (if it is to be assumed that this basket was woven from sound material in the first place) that the basket was stored in improper conditions at some point and perhaps suffered either severe dehydration or perhaps microbial attack (ie. de-lignification by fungal attack which would disrupt both structure and hydrophobic lignin content (Blanchette et al. 1985)). This severe deterioration might account for the unexpected behavior of the basketry spruce root (SR-B) sample set, and is useful to note for this reason.

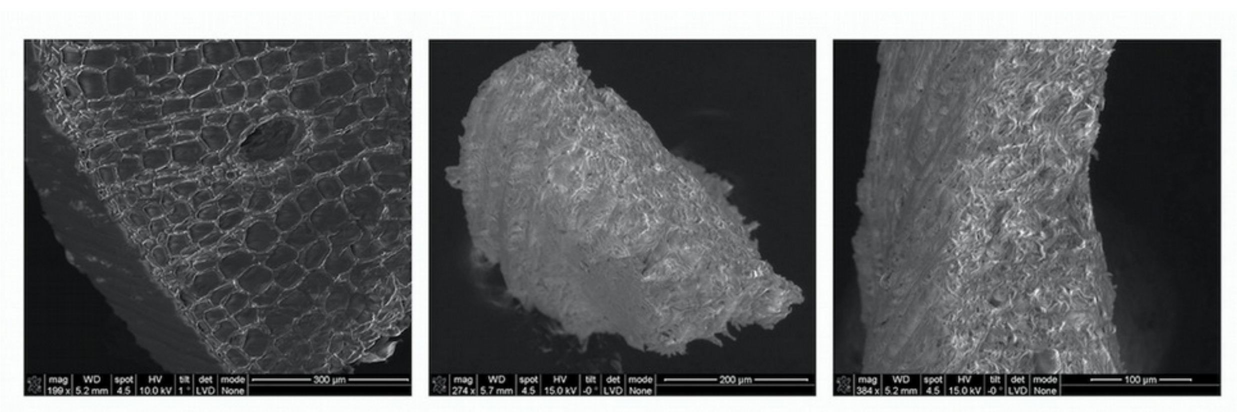


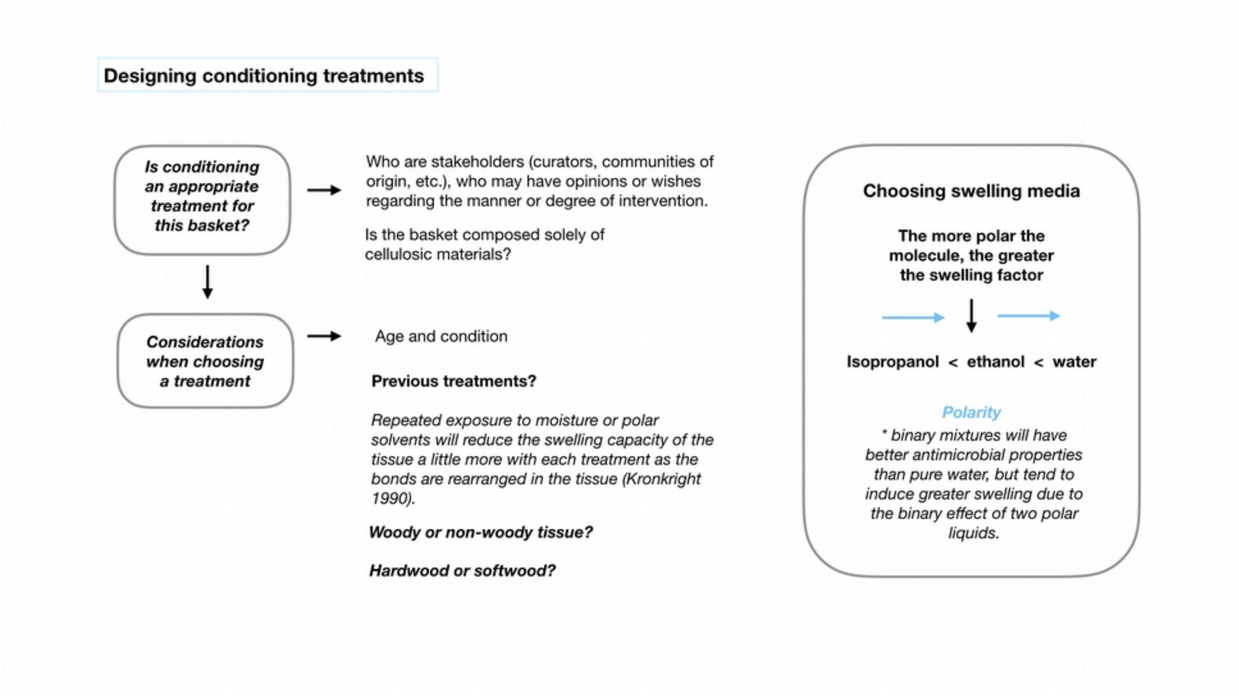
Figure 10: Sound spruce root sample (left) at 199x magnification compared with two degraded spruce root (basketry) samples at the same orientation, the middle image at 274x and the right at 384x. Note the near complete loss of definition of cell walls which seem to have collapsed in the two deteriorated samples (both from the sampled Tlingit basket).

7. Conclusion

While it is relatively straightforward to observe swelling and recovery, it is much harder to identify and assess whether ‘damage’ has occurred. What remains important is that every conservation treatments induces change of some kind, even if that change difficult or impossible to see with the naked eye, and it is a matter of defining the range of unacceptable change which allows us to define damage.

In the case of conditioning basketry fibers, the repeated cycles of swelling and recovery are not a perfect back and forth, the hydrogen bonds between fibers can never return to exactly the same positions. Any movement of the cellulose fibers will impart change to the system, even if each individual change is very small. Mechanosorptive creep, or the permanent dimensional change induced by repeated cycles of adsorption and evaporation of moisture or solvent within the cellulosic structure, is permanent and cumulative, and over time also reduces the material’s responsiveness to subsequent swelling due to the formation of more permanent bonds between components. In the end, the safety of the basket must always be paramount, and when there are many unknowns and variables which are difficult to control, treatment measures should always be conservative, thoughtful and carefully monitored.

While every conservation lab is different and resources or institutional expectations may vary, this chart touches upon questions which are readily answerable in any lab setting and which help to inform as tailored a treatment as possible. Since no basket is identical to another, it makes sense, when possible, to fine-tune treatments to minimize the impact and any long-term changes to the material.



The results of this study are useful for conservators seeking to design the safest parameters for conditioning treatments of basketry. When taken with data from other studies, the author was able to compile a flowchart outlining a comprehensive view of some of the most important variables which can influence conditioning treatments, in particular the properties of both the plant materials and the swelling media. While this study could not investigate all possible variables, it was able to extrapolate larger trends – based upon the chemistry of cellulosic plant tissue and its interaction with polar molecules – which are applicable to a wider variety of basketry objects and treatment situations.

This leads into broader questions regarding treatment protocols, and whether conditioning is an appropriate treatment especially in the context of Indigenous, American Indian, and First Nations basketry. Conditioning and the reshaping it facilitates is by nature invasive and automatically involves structural and aesthetic judgement and decision making by the conservator and any other stakeholders involved in the treatment. This is not at all to imply that conservation is inappropriate, rather that care should be taken to ascertain where the visions of the museum and the those of the community of origin align, and where mutual agreement or understanding can be reached. Some communities may object to the alteration of baskets whose damage may hold significance, or prefer that baskets age and deteriorate, so as to 'die' naturally. For some, the stasis of museum storage or even display, can threaten the life-force of a basket which is intended to be used, handled, mended, and fully integrated into human life. At the same time, museums do also have an obligation to their collections, and in some cases, conservation is necessary in order to preserve an object of great significance to the collection. But either way, communication between museums and communities is key. Agreements or compromises reached may result in anything from no treatment at all to 'complete' treatment in the Western sense. Conditioning is just one of many treatments a basket might undergo; the important point is that decisions regarding treatments, not just of basketry but of all objects, be as informed as possible, from all sides.

Appendix – data tables

Spruce root basketry 1 (water) - Width of elements before, during and after treatment

SR1 (H2O) Element widths before treatment

Sample area	Title	Measurement Result		
	Date saved	3/1/2017	12:23 PM	
	No.	Measure	Result	Unit
Spot # 1 - element width	1	2 Points	1109.48	µm
	2	2 Points	1114.28	µm
	3	2 Points	1102.7	µm
	4	2 Points	1100.58	µm
	5	2 Points	1107	µm
		Average	1106.81	
		Standard Deviation (σ)	5.45	
		% Relative Standard Deviation (%RSD)	0.49	
Spot # 2 - element width	6	2 Points	1049.69	µm
	7	2 Points	1050.47	µm
	8	2 Points	1049.19	µm
	9	2 Points	1047.83	µm
	10	2 Points	1051.98	µm
		Average	1049.83	
		Standard Deviation (σ)	1.54	
		% Relative Standard Deviation (%RSD)	0.15	
Spot # 3 - element width	11	2 Points	1093.4	µm
	12	2 Points	1102.9	µm
	13	2 Points	1114.3	µm
	14	2 Points	1100.87	µm
	15	2 Points	1102.91	µm
		Average	1102.88	
		Standard Deviation (σ)	7.49	
		% Relative Standard Deviation (%RSD)	0.68	
Spot # 4 - element width	16	2 Points	1082.38	µm
	17	2 Points	1069.75	µm
	18	2 Points	1081.02	µm
	19	2 Points	1067.93	µm
	20	2 Points	1072.69	µm
		Average	1074.75	
		Standard Deviation (σ)	6.58	
		% Relative Standard Deviation (%RSD)	0.61	
Spot # 5 - element width	21	2 Points	1047.36	µm
	22	2 Points	1043.36	µm
	23	2 Points	1044.16	µm
	24	2 Points	1034.76	µm
	25	2 Points	1037.68	µm
		Average	1041.46	
		Standard Deviation (σ)	5.12	
		% Relative Standard Deviation (%RSD)	0.49	
Spot # 6 - element width	26	2 Points	1004.67	µm
	27	2 Points	1003.48	µm
	28	2 Points	997.23	µm
	29	2 Points	1000.47	µm
	30	2 Points	1000.93	µm
		Average	1001.36	
		Standard Deviation (σ)	2.89	
		% Relative Standard Deviation (%RSD)	0.29	
Spot # 7 - element width	31	2 Points	1130.95	µm
	32	2 Points	1117	µm
	33	2 Points	1120.48	µm
	34	2 Points	1118.84	µm
	35	2 Points	1118.28	µm
		Average	1121.11	
		Standard Deviation (σ)	5.64	
		% Relative Standard Deviation (%RSD)	0.50	
Spot # 8 - element width	36	2 Points	968	µm
	37	2 Points	965.51	µm
	38	2 Points	959.95	µm
	39	2 Points	967.74	µm
	40	2 Points	964.12	µm
		Average	965.06	
		Standard Deviation (σ)	3.28	

SR1 (H2O) Element widths during conditioning

Title	Measurement Result		
Date saved	4/10/2017	11:12 AM	
No.	Measure	Result	Unit
1	2 Points	1120.54	µm
2	2 Points	1119.54	µm
3	2 Points	1122.16	µm
4	2 Points	1118.99	µm
5	2 Points	1118.7	µm
	Average	1119.99	
	Standard Deviation (σ)	1.40	
	% Relative Standard Deviation (%RSD)	0.13	
6	2 Points	1127.08	µm
7	2 Points	1126.46	µm
8	2 Points	1116.97	µm
9	2 Points	1131.69	µm
10	2 Points	1124.14	µm
	Average	1125.27	
	Standard Deviation (σ)	5.39	
	% Relative Standard Deviation (%RSD)	0.48	
11	2 Points	1120.87	µm
12	2 Points	1110.68	µm
13	2 Points	1109.04	µm
14	2 Points	1114.95	µm
15	2 Points	1112.95	µm
	Average	1113.70	
	Standard Deviation (σ)	4.59	
	% Relative Standard Deviation (%RSD)	0.41	
16	2 Points	1078.04	µm
17	2 Points	1079.95	µm
18	2 Points	1067.19	µm
19	2 Points	1081.51	µm
20	2 Points	1084.6	µm
	Average	1078.26	
	Standard Deviation (σ)	6.64	
	% Relative Standard Deviation (%RSD)	0.62	
21	2 Points	1055.86	µm
22	2 Points	1053.76	µm
23	2 Points	1053.31	µm
24	2 Points	1061.87	µm
25	2 Points	1055.77	µm
	Average	1056.11	
	Standard Deviation (σ)	3.42	
	% Relative Standard Deviation (%RSD)	0.32	
26	2 Points	1086.34	µm
27	2 Points	1089.6	µm
28	2 Points	1085.08	µm
29	2 Points	1095.35	µm
30	2 Points	1088.69	µm
	Average	1089.01	
	Standard Deviation (σ)	3.98	
	% Relative Standard Deviation (%RSD)	0.37	
31	2 Points	1138.38	µm
32	2 Points	1144.12	µm
33	2 Points	1144.73	µm
34	2 Points	1132.33	µm
35	2 Points	1150.14	µm
	Average	1141.94	
	Standard Deviation (σ)	6.80	
	% Relative Standard Deviation (%RSD)	0.60	
36	2 Points	983.79	µm
37	2 Points	975.55	µm
38	2 Points	969.09	µm
39	2 Points	977.15	µm
40	2 Points	976.35	µm
	Average	976.39	
	Standard Deviation (σ)	5.23	

SR1 (H2O) Element widths after recovery

Title	Measurement Result			
Date saved	4/14/2017	10:12 AM		
No.	Measure	Result	Unit	% Change (µm)
1	2 Points	1111.26	µm	
2	2 Points	1107.09	µm	
3	2 Points	1099.33	µm	
4	2 Points	1100.32	µm	
5	2 Points	1105.61	µm	
	Average	1104.72		-0.19
	Standard Deviation (σ)	4.94		
	% Relative Standard Deviation (%RSD)	0.45		
6	2 Points	1023.95	µm	
7	2 Points	1034.89	µm	
8	2 Points	1033.18	µm	
9	2 Points	1027.96	µm	
10	2 Points	1031.47	µm	
	Average	1030.29		-1.86
	Standard Deviation (σ)	4.37		
	% Relative Standard Deviation (%RSD)	0.42		
11	2 Points	1106.04	µm	
12	2 Points	1096.06	µm	
13	2 Points	1096.61	µm	
14	2 Points	1098.59	µm	
15	2 Points	1095.92	µm	
	Average	1098.64		-0.38
	Standard Deviation (σ)	4.27		
	% Relative Standard Deviation (%RSD)	0.39		
16	2 Points	1095.93	µm	
17	2 Points	1096.72	µm	
18	2 Points	1097.31	µm	
19	2 Points	1100.47	µm	
20	2 Points	1087.53	µm	
	Average	1095.59		1.94
	Standard Deviation (σ)	4.83		
	% Relative Standard Deviation (%RSD)	0.44		
21	2 Points	1050.72	µm	
22	2 Points	1053.63	µm	
23	2 Points	1044.65	µm	
24	2 Points	1049.68	µm	
25	2 Points	1058.71	µm	
	Average	1051.48		0.96
	Standard Deviation (σ)	5.18		
	% Relative Standard Deviation (%RSD)	0.49		
26	2 Points	1012.1	µm	
27	2 Points	1001.74	µm	
28	2 Points	1013.88	µm	
29	2 Points	1002.82	µm	
30	2 Points	1014.33	µm	
	Average	1008.97		0.76
	Standard Deviation (σ)	6.18		
	% Relative Standard Deviation (%RSD)	0.61		
31	2 Points	1113.53	µm	
32	2 Points	1135.8	µm	
33	2 Points	1137.16	µm	
34	2 Points	1134.84	µm	
35	2 Points	1134.76	µm	
	Average	1131.22		0.90
	Standard Deviation (σ)	9.94		
	% Relative Standard Deviation (%RSD)	0.88		
36	2 Points	967.47	µm	
37	2 Points	972.18	µm	
38	2 Points	971.96	µm	
39	2 Points	964.53	µm	
40	2 Points	967.95	µm	
	Average	968.82		0.39
	Standard Deviation (σ)	3.25		

		% Relative Standard Deviation (%RSD)	0.34	
Spot # 9 - element width	41	2 Points	1010.46	µm
	42	2 Points	1002.85	µm
	43	2 Points	1002.84	µm
	44	2 Points	1005.49	µm
	45	2 Points	1005.02	µm
		Average	1005.33	
		Standard Deviation (σ)	3.11	
		% Relative Standard Deviation (%RSD)	0.31	
Spot # 10 - element width	46	2 Points	1186	µm
	47	2 Points	1185.69	µm
	48	2 Points	1184.71	µm
	49	2 Points	1188.46	µm
	50	2 Points	1189.98	µm
		Average	1186.97	
		Standard Deviation (σ)	2.18	
		% Relative Standard Deviation (%RSD)	0.18	

		% Relative Standard Deviation (%RSD)	0.54	
	41	2 Points	1114.88	µm
	42	2 Points	1095.09	µm
	43	2 Points	1098.04	µm
	44	2 Points	1111.52	µm
	45	2 Points	1101.99	µm
		Average	1104.30	
		Standard Deviation (σ)	8.56	
		% Relative Standard Deviation (%RSD)	0.78	
	46	2 Points	1222.08	µm
	47	2 Points	1232.38	µm
	48	2 Points	1220.45	µm
	49	2 Points	1215.46	µm
	50	2 Points	1224.47	µm
		Average	1222.97	
		Standard Deviation (σ)	6.21	
		% Relative Standard Deviation (%RSD)	0.51	

		% Relative Standard Deviation (%RSD)	0.33		
	41	2 Points	1015.08	µm	
	42	2 Points	1025.51	µm	
	43	2 Points	1019.54	µm	
	44	2 Points	1011.36	µm	
	45	2 Points	1005.6	µm	
		Average	1015.42		1.00
		Standard Deviation (σ)	7.61		
		% Relative Standard Deviation (%RSD)	0.75		
	46	2 Points	1180.62	µm	
	47	2 Points	1173.26	µm	
	48	2 Points	1188.71	µm	
	49	2 Points	1187.33	µm	
	50	2 Points	1184.01	µm	
		Average	1182.79		-0.35
		Standard Deviation (σ)	6.18		
		% Relative Standard Deviation (%RSD)	0.52		
		Average % change			0.32

Spruce root basketry 2 (ethanol) - Width of elements before, during and after treatment

SR2 (EtOH) Element widths before treatment

Title	Measurement Result		
Date saved	3/1/2017	12:55 PM	
No.	Measure	Result	Unit
1	2 Points	1150.88	µm
2	2 Points	1151.78	µm
3	2 Points	1152.34	µm
4	2 Points	1151.15	µm
5	2 Points	1150	µm
	Average	1151.23	
	Standard Deviation (σ)	0.89	
	% Relative Standard Deviation (%RSD)	0.87	
6	2 Points	1129.22	µm
7	2 Points	1137.27	µm
8	2 Points	1127.35	µm
9	2 Points	1128.1	µm
10	2 Points	1130.97	µm
	Average	1130.58	
	Standard Deviation (σ)	3.98	
	% Relative Standard Deviation (%RSD)	3.91	
11	2 Points	1127.57	µm
12	2 Points	1131.36	µm
13	2 Points	1130.88	µm
14	2 Points	1136.63	µm
15	2 Points	1133.5	µm
	Average	1131.99	
	Standard Deviation (σ)	3.35	
	% Relative Standard Deviation (%RSD)	2.32	
16	2 Points	1065.03	µm
17	2 Points	1066	µm
18	2 Points	1071.82	µm
19	2 Points	1064.08	µm
20	2 Points	1064.65	µm
	Average	1066.32	
	Standard Deviation (σ)	3.16	
	% Relative Standard Deviation (%RSD)	3.08	
21	2 Points	1237.67	µm
22	2 Points	1231.38	µm
23	2 Points	1235.98	µm
24	2 Points	1242.81	µm
25	2 Points	1253.59	µm
	Average	1240.29	
	Standard Deviation (σ)	8.49	
	% Relative Standard Deviation (%RSD)	8.36	
26	2 Points	1301.07	µm
27	2 Points	1295.13	µm
28	2 Points	1300.78	µm
29	2 Points	1296.79	µm
30	2 Points	1307.81	µm
	Average	1300.32	
	Standard Deviation (σ)	4.91	
	% Relative Standard Deviation (%RSD)	4.89	
31	2 Points	1172.36	µm
32	2 Points	1157.34	µm
33	2 Points	1153.74	µm
34	2 Points	1156.04	µm
35	2 Points	1160.24	µm
	Average	1159.94	
	Standard Deviation (σ)	7.33	

SR2 (EtOH) Element widths during conditioning

Title	Measurement Result		
Date saved	4/10/2017	11:59 AM	
No.	Measure	Result	Unit
1	2 Points	1174.35	µm
2	2 Points	1181.92	µm
3	2 Points	1174.94	µm
4	2 Points	1182.17	µm
5	2 Points	1173.07	µm
	Average	1177.29	
	Standard Deviation (σ)	4.39	
	% Relative Standard Deviation (%RSD)	4.09	
6	2 Points	1147.37	µm
7	2 Points	1136.53	µm
8	2 Points	1145.25	µm
9	2 Points	1137.91	µm
10	2 Points	1144.88	µm
	Average	1142.39	
	Standard Deviation (σ)	4.84	
	% Relative Standard Deviation (%RSD)	3.99	
11	2 Points	1154.05	µm
12	2 Points	1157.73	µm
13	2 Points	1153.06	µm
14	2 Points	1162.29	µm
15	2 Points	1155.62	µm
	Average	1156.55	
	Standard Deviation (σ)	3.66	
	% Relative Standard Deviation (%RSD)	3.40	
16	2 Points	1082.77	µm
17	2 Points	1066.15	µm
18	2 Points	1071.22	µm
19	2 Points	1080.82	µm
20	2 Points	1078.73	µm
	Average	1075.94	
	Standard Deviation (σ)	7.01	
	% Relative Standard Deviation (%RSD)	5.92	
21	2 Points	1270.79	µm
22	2 Points	1259.01	µm
23	2 Points	1262.38	µm
24	2 Points	1255.74	µm
25	2 Points	1264.83	µm
	Average	1262.55	
	Standard Deviation (σ)	5.75	
	% Relative Standard Deviation (%RSD)	3.56	
26	2 Points	1317.54	µm
27	2 Points	1299.55	µm
28	2 Points	1310.96	µm
29	2 Points	1304.29	µm
30	2 Points	1310.83	µm
	Average	1308.63	
	Standard Deviation (σ)	6.91	
	% Relative Standard Deviation (%RSD)	4.89	
31	2 Points	1189.48	µm
32	2 Points	1159.29	µm
33	2 Points	1181	µm
34	2 Points	1168.15	µm
35	2 Points	1161.14	µm
	Average	1171.81	
	Standard Deviation (σ)	13.04	

SR2 (EtOH) Element widths after drying

Title	Measurement Result			
Date saved	4/14/2017	10:50 AM		
No.	Measure	Result	Unit	% Change (µm)
1	2 Points	1169.96	µm	
2	2 Points	1188.54	µm	
3	2 Points	1193.36	µm	
4	2 Points	1184.37	µm	
5	2 Points	1183.74	µm	
	Average	1183.99		2.85
	Standard Deviation (σ)	8.74		
	% Relative Standard Deviation (%RSD)	4.16		
6	2 Points	1123.06	µm	
7	2 Points	1131.47	µm	
8	2 Points	1131.47	µm	
9	2 Points	1137.28	µm	
10	2 Points	1134.7	µm	
	Average	1131.60		0.09
	Standard Deviation (σ)	460.30		
	% Relative Standard Deviation (%RSD)	2.62		
11	2 Points	1144.71	µm	
12	2 Points	1148.76	µm	
13	2 Points	1142.23	µm	
14	2 Points	1156.92	µm	
15	2 Points	1167.51	µm	
	Average	1152.03		1.77
	Standard Deviation (σ)	10.29		
	% Relative Standard Deviation (%RSD)	9.48		
16	2 Points	1060.28	µm	
17	2 Points	1062.65	µm	
18	2 Points	1054.37	µm	
19	2 Points	1066.77	µm	
20	2 Points	1076.97	µm	
	Average	1064.21		-0.20
	Standard Deviation (σ)	8.43		
	% Relative Standard Deviation (%RSD)	8.15		
21	2 Points	1247.4	µm	
22	2 Points	1246.09	µm	
23	2 Points	1260.31	µm	
24	2 Points	1240.54	µm	
25	2 Points	1238.48	µm	
	Average	1246.56		0.51
	Standard Deviation (σ)	8.54		
	% Relative Standard Deviation (%RSD)	8.52		
26	2 Points	1285.53	µm	
27	2 Points	1307.14	µm	
28	2 Points	1290.07	µm	
29	2 Points	1291.05	µm	
30	2 Points	1294.4	µm	
	Average	1293.64		-0.51
	Standard Deviation (σ)	8.19		
	% Relative Standard Deviation (%RSD)	6.88		
31	2 Points	1211.66	µm	
32	2 Points	1199.03	µm	
33	2 Points	1183.76	µm	
34	2 Points	1191.61	µm	
35	2 Points	1177.33	µm	
	Average	1192.68		2.82
	Standard Deviation (σ)	13.39		

	% Relative Standard Deviation (%RSD)	2.73	
36	2 Points	1231.02	µm
37	2 Points	1227.54	µm
38	2 Points	1228.21	µm
39	2 Points	1226.54	µm
40	2 Points	1223.68	µm
	Average	1227.40	
	Standard Deviation (σ)	2.66	
	% Relative Standard Deviation (%RSD)	1.78	
41	2 Points	1182.62	µm
42	2 Points	1157.44	µm
43	2 Points	1156.09	µm
44	2 Points	1159.15	µm
45	2 Points	1154.95	µm
	Average	1162.05	
	Standard Deviation (σ)	11.61	
	% Relative Standard Deviation (%RSD)	2.78	
46	2 Points	1078.46	µm
47	2 Points	1066.52	µm
48	2 Points	1066.17	µm
49	2 Points	1065.61	µm
50	2 Points	1056.7	µm
	Average	1066.69	
	Standard Deviation (σ)	7.74	
	% Relative Standard Deviation (%RSD)	4.29	

	% Relative Standard Deviation (%RSD)	8.75	
36	2 Points	1251.38	µm
37	2 Points	1245.89	µm
38	2 Points	1249.91	µm
39	2 Points	1244.06	µm
40	2 Points	1242.46	µm
	Average	1246.74	
	Standard Deviation (σ)	3.80	
	% Relative Standard Deviation (%RSD)	2.83	
41	2 Points	1179.04	µm
42	2 Points	1174.64	µm
43	2 Points	1194.41	µm
44	2 Points	1185.96	µm
45	2 Points	1165.25	µm
	Average	1179.86	
	Standard Deviation (σ)	11.07	
	% Relative Standard Deviation (%RSD)	11.06	
46	2 Points	1085.3	µm
47	2 Points	1079.85	µm
48	2 Points	1081.5	µm
49	2 Points	1076.1	µm
50	2 Points	1081.58	µm
	Average	1080.87	
	Standard Deviation (σ)	3.33	
	% Relative Standard Deviation (%RSD)	2.28	

	% Relative Standard Deviation (%RSD)	8.43		
36	2 Points	1233.2	µm	
37	2 Points	1231.93	µm	
38	2 Points	1229.89	µm	
39	2 Points	1219.14	µm	
40	2 Points	1207.1	µm	
	Average	1224.25		-0.26
	Standard Deviation (σ)	11.08		
	% Relative Standard Deviation (%RSD)	9.94		
41	2 Points	1193.02	µm	
42	2 Points	1192.95	µm	
43	2 Points	1194.16	µm	
44	2 Points	1169.5	µm	
45	2 Points	1185.75	µm	
	Average	1187.08		2.15
	Standard Deviation (σ)	10.38		
	% Relative Standard Deviation (%RSD)	9.85		
46	2 Points	1038.85	µm	
47	2 Points	1033.86	µm	
48	2 Points	1049.16	µm	
49	2 Points	1037.51	µm	
50	2 Points	1032.38	µm	
	Average	1038.35		-2.66
	Standard Deviation (σ)	6.59		
	% Relative Standard Deviation (%RSD)	6.58		
	Average % change			0.66

Spruce root basketry 3 (70:30 water:ethanol) - Width of elements before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	3/1/2017	1:21 PM	
No.	Measure	Result	Unit
1	2 Points	935.84	µm
2	2 Points	945.93	µm
3	2 Points	929.33	µm
4	2 Points	940.65	µm
5	2 Points	929.27	µm
	Average	936.20	
	Standard Deviation (σ)	7.24	
	% Relative Standard Deviation (%RSD)	0.77	
6	2 Points	1048.22	µm
7	2 Points	1073.74	µm
8	2 Points	1073.12	µm
9	2 Points	1086.83	µm
10	2 Points	1064.96	µm
	Average	1069.37	
	Standard Deviation (σ)	14.18	
	% Relative Standard Deviation (%RSD)	1.33	
11	2 Points	1039.2	µm
12	2 Points	1049.41	µm
13	2 Points	1035.83	µm
14	2 Points	1050.5	µm
15	2 Points	1037.04	µm
	Average	1042.40	
	Standard Deviation (σ)	7.02	
	% Relative Standard Deviation (%RSD)	0.67	
16	2 Points	1095.76	µm
17	2 Points	1087.35	µm
18	2 Points	1089.01	µm
19	2 Points	1085.18	µm
20	2 Points	1088.18	µm
	Average	1089.10	
	Standard Deviation (σ)	3.99	
	% Relative Standard Deviation (%RSD)	0.37	
21	2 Points	959.6	µm
22	2 Points	986.37	µm
23	2 Points	961.28	µm
24	2 Points	965.8	µm
25	2 Points	971.13	µm
	Average	968.84	
	Standard Deviation (σ)	10.77	
	% Relative Standard Deviation (%RSD)	1.11	
26	2 Points	882.27	µm
27	2 Points	889.52	µm
28	2 Points	885.34	µm
29	2 Points	891.72	µm
30	2 Points	883.82	µm
	Average	886.53	
	Standard Deviation (σ)	3.96	
	% Relative Standard Deviation (%RSD)	0.45	
31	2 Points	1161.34	µm
32	2 Points	1161.9	µm
33	2 Points	1173.3	µm
34	2 Points	1152.6	µm
35	2 Points	1161.43	µm
	Average	1162.11	
	Standard Deviation (σ)	7.36	

During treatment

Title	Measurement Result		
Date saved	4/10/2017	12:45 PM	
No.	Measure	Result	Unit
1	2 Points	977.33	µm
2	2 Points	963.35	µm
3	2 Points	950.33	µm
4	2 Points	958.62	µm
5	2 Points	955.95	µm
	Average	961.12	
	Standard Deviation (σ)	10.21	
	% Relative Standard Deviation (%RSD)	1.06	
6	2 Points	1046.74	µm
7	2 Points	1046.79	µm
8	2 Points	1043.56	µm
9	2 Points	1043.07	µm
10	2 Points	1050.84	µm
	Average	1046.20	
	Standard Deviation (σ)	3.12	
	% Relative Standard Deviation (%RSD)	0.30	
11	2 Points	1054.78	µm
12	2 Points	1046.21	µm
13	2 Points	1036.3	µm
14	2 Points	1040.86	µm
15	2 Points	1026.75	µm
	Average	1040.98	
	Standard Deviation (σ)	10.51	
	% Relative Standard Deviation (%RSD)	1.01	
16	2 Points	1089.78	µm
17	2 Points	1071.94	µm
18	2 Points	1094.22	µm
19	2 Points	1091.01	µm
20	2 Points	1094.62	µm
	Average	1088.31	
	Standard Deviation (σ)	9.38	
	% Relative Standard Deviation (%RSD)	0.86	
21	2 Points	975.37	µm
22	2 Points	975.97	µm
23	2 Points	975.16	µm
24	2 Points	983.76	µm
25	2 Points	969.47	µm
	Average	975.95	
	Standard Deviation (σ)	5.10	
	% Relative Standard Deviation (%RSD)	0.52	
26	2 Points	897.68	µm
27	2 Points	898.11	µm
28	2 Points	907.58	µm
29	2 Points	908.37	µm
30	2 Points	902.25	µm
	Average	902.80	
	Standard Deviation (σ)	5.06	
	% Relative Standard Deviation (%RSD)	0.56	
31	2 Points	1184.22	µm
32	2 Points	1192.05	µm
33	2 Points	1186.48	µm
34	2 Points	1184.4	µm
35	2 Points	1176.33	µm
	Average	1184.70	
	Standard Deviation (σ)	5.65	

After treatment

Title	Measurement Result			
Date saved	4/14/2017	11:17 AM		
No.	Measure	Result	Unit	% Change (µm)
1	2 Points	973.82	µm	
2	2 Points	973.91	µm	
3	2 Points	959.67	µm	
4	2 Points	960.05	µm	
5	2 Points	961.06	µm	
	Average	965.70		3.151
	Standard Deviation (σ)	7.47		
	% Relative Standard Deviation (%RSD)	0.77		
6	2 Points	1071.38	µm	
7	2 Points	1077.89	µm	
8	2 Points	1051.99	µm	
9	2 Points	1057.99	µm	
10	2 Points	1055.52	µm	
	Average	1062.95		-0.600
	Standard Deviation (σ)	11.12		
	% Relative Standard Deviation (%RSD)	1.05		
11	2 Points	1046.77	µm	
12	2 Points	1045.29	µm	
13	2 Points	1040.82	µm	
14	2 Points	1044.99	µm	
15	2 Points	1039.65	µm	
	Average	1043.50		0.106
	Standard Deviation (σ)	3.09		
	% Relative Standard Deviation (%RSD)	0.30		
16	2 Points	1099.76	µm	
17	2 Points	1108.9	µm	
18	2 Points	1103.68	µm	
19	2 Points	1096.25	µm	
20	2 Points	1084.52	µm	
	Average	1098.62		0.875
	Standard Deviation (σ)	9.18		
	% Relative Standard Deviation (%RSD)	0.84		
21	2 Points	977.28	µm	
22	2 Points	980.05	µm	
23	2 Points	963.88	µm	
24	2 Points	971.94	µm	
25	2 Points	996.07	µm	
	Average	977.84		0.930
	Standard Deviation (σ)	11.91		
	% Relative Standard Deviation (%RSD)	1.22		
26	2 Points	894.01	µm	
27	2 Points	906.78	µm	
28	2 Points	903.87	µm	
29	2 Points	892.57	µm	
30	2 Points	914.1	µm	
	Average	902.27		1.775
	Standard Deviation (σ)	9.02		
	% Relative Standard Deviation (%RSD)	1.00		
31	2 Points	1178.67	µm	
32	2 Points	1177.44	µm	
33	2 Points	1170.3	µm	
34	2 Points	1175.6	µm	
35	2 Points	1189.74	µm	
	Average	1178.35		1.397
	Standard Deviation (σ)	7.12		

	% Relative Standard Deviation (%RSD)	0.63	
36	2 Points	1217.67	µm
37	2 Points	1217.22	µm
38	2 Points	1210.21	µm
39	2 Points	1228.03	µm
40	2 Points	1220.24	µm
	Average	1218.67	
	Standard Deviation (σ)	6.42	
	% Relative Standard Deviation (%RSD)	0.53	
41	2 Points	974.71	µm
42	2 Points	977.61	µm
43	2 Points	975.33	µm
44	2 Points	963.42	µm
45	2 Points	979.24	µm
	Average	974.06	
	Standard Deviation (σ)	6.22	
	% Relative Standard Deviation (%RSD)	0.64	
46	2 Points	1014.96	µm
47	2 Points	1006.29	µm
48	2 Points	1011.02	µm
49	2 Points	1017.25	µm
50	2 Points	1007.86	µm
	Average	1011.48	
	Standard Deviation (σ)	4.63	
	% Relative Standard Deviation (%RSD)	0.46	

	% Relative Standard Deviation (%RSD)	0.48	
36	2 Points	1231.86	µm
37	2 Points	1226.13	µm
38	2 Points	1232.69	µm
39	2 Points	1225.72	µm
40	2 Points	1222.61	µm
	Average	1227.80	
	Standard Deviation (σ)	4.31	
	% Relative Standard Deviation (%RSD)	0.35	
41	2 Points	972.77	µm
42	2 Points	978.21	µm
43	2 Points	974.49	µm
44	2 Points	982.88	µm
45	2 Points	974.25	µm
	Average	976.52	
	Standard Deviation (σ)	4.08	
	% Relative Standard Deviation (%RSD)	0.42	
46	2 Points	1029.14	µm
47	2 Points	1025.92	µm
48	2 Points	1023.93	µm
49	2 Points	1012.14	µm
50	2 Points	1014.81	µm
	Average	1021.19	
	Standard Deviation (σ)	7.34	
	% Relative Standard Deviation (%RSD)	0.72	

	% Relative Standard Deviation (%RSD)	0.60		
36	2 Points	1214.35	µm	
37	2 Points	1227.45	µm	
38	2 Points	1228.14	µm	
39	2 Points	1232.02	µm	
40	2 Points	1220.77	µm	
	Average	1224.55		0.482
	Standard Deviation (σ)	6.99		
	% Relative Standard Deviation (%RSD)	0.57		
41	2 Points	959.22	µm	
42	2 Points	956.48	µm	
43	2 Points	975.38	µm	
44	2 Points	968.58	µm	
45	2 Points	965.24	µm	
	Average	964.98		-0.932
	Standard Deviation (σ)	7.53		
	% Relative Standard Deviation (%RSD)	0.78		
46	2 Points	1034.4	µm	
47	2 Points	1029.06	µm	
48	2 Points	1019.6	µm	
49	2 Points	1019.23	µm	
50	2 Points	1030.95	µm	
	Average	1026.65		1.500
	Standard Deviation (σ)	6.88		
	% Relative Standard Deviation (%RSD)	0.67		
	Average % change			0.868

Spruce root basketry 4 (50:50 water:ethanol) - Width of elements before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	3/1/2017	1:47 PM	
Comment			
[Main]			
No.	Measure	Result	Unit
1	2 Points	1086.42	µm
2	2 Points	1090.85	µm
3	2 Points	1082.19	µm
4	2 Points	1080.53	µm
5	2 Points	1090.72	µm
	Average	1086.14	
	Standard Deviation (σ)	4.75	
	% Relative Standard Deviation (%RSD)	0.44	
6	2 Points	1206.71	µm
7	2 Points	1211.21	µm
8	2 Points	1195.89	µm
9	2 Points	1210.02	µm
10	2 Points	1197.76	µm
	Average	1204.32	
	Standard Deviation (σ)	7.07	
	% Relative Standard Deviation (%RSD)	0.59	
11	2 Points	1148.01	µm
12	2 Points	1154.82	µm
13	2 Points	1157.81	µm
14	2 Points	1150.05	µm
15	2 Points	1149.88	µm
	Average	1152.11	
	Standard Deviation (σ)	4.06	
	% Relative Standard Deviation (%RSD)	0.35	
16	2 Points	1168.46	µm
17	2 Points	1170.68	µm
18	2 Points	1161.33	µm
19	2 Points	1161.75	µm
20	2 Points	1165.71	µm
	Average	1165.59	
	Standard Deviation (σ)	4.09	
	% Relative Standard Deviation (%RSD)	0.35	
21	2 Points	1244.51	µm
22	2 Points	1239.85	µm
23	2 Points	1240.69	µm
24	2 Points	1242.76	µm
25	2 Points	1242.82	µm
	Average	1242.13	
	Standard Deviation (σ)	1.86	
	% Relative Standard Deviation (%RSD)	0.15	
26	2 Points	1089.05	µm
27	2 Points	1093.97	µm
28	2 Points	1091.03	µm
29	2 Points	1098.55	µm
30	2 Points	1105.21	µm
	Average	1095.56	
	Standard Deviation (σ)	6.47	
	% Relative Standard Deviation (%RSD)	0.59	
31	2 Points	1012.95	µm
32	2 Points	1006.79	µm
33	2 Points	1009.11	µm
34	2 Points	1000.3	µm
35	2 Points	1012.22	µm

During treatment

Title	Measurement Result		
Date saved	4/10/2017	1:17 PM	
Comment			
[Main]			
No.	Measure	Result	Unit
1	2 Points	1080.95	µm
2	2 Points	1098.62	µm
3	2 Points	1086.82	µm
4	2 Points	1086.61	µm
5	2 Points	1089.28	µm
	Average	1088.46	
	Standard Deviation (σ)	6.45	
	% Relative Standard Deviation (%RSD)	0.59	
6	2 Points	1183.2	µm
7	2 Points	1190.35	µm
8	2 Points	1195.46	µm
9	2 Points	1187.95	µm
10	2 Points	1197.89	µm
	Average	1190.97	
	Standard Deviation (σ)	5.87	
	% Relative Standard Deviation (%RSD)	0.49	
11	2 Points	1155.93	µm
12	2 Points	1160.28	µm
13	2 Points	1172.43	µm
14	2 Points	1160.68	µm
15	2 Points	1154.33	µm
	Average	1160.73	
	Standard Deviation (σ)	7.09	
	% Relative Standard Deviation (%RSD)	0.61	
16	2 Points	1072.18	µm
17	2 Points	1079.1	µm
18	2 Points	1080.74	µm
19	2 Points	1081.94	µm
20	2 Points	1084.05	µm
	Average	1079.60	
	Standard Deviation (σ)	4.52	
	% Relative Standard Deviation (%RSD)	0.42	
21	2 Points	1125.09	µm
22	2 Points	1109.42	µm
23	2 Points	1109.76	µm
24	2 Points	1104.6	µm
25	2 Points	1116.92	µm
	Average	1113.16	
	Standard Deviation (σ)	7.99	
	% Relative Standard Deviation (%RSD)	0.72	
26	2 Points	1118.3	µm
27	2 Points	1116.3	µm
28	2 Points	1117.44	µm
29	2 Points	1132.91	µm
30	2 Points	1134.81	µm
	Average	1123.95	
	Standard Deviation (σ)	9.10	
	% Relative Standard Deviation (%RSD)	0.81	
31	2 Points	1019.73	µm
32	2 Points	1016.66	µm
33	2 Points	1019.82	µm
34	2 Points	1020.36	µm
35	2 Points	1023.14	µm

After treatment

Title	Measurement Result			
Date saved	4/14/2017	11:42 AM		
Comment				
[Main]				
No.	Measure	Result	Unit	% Change (µm)
1	2 Points	1075.12	µm	
2	2 Points	1080.05	µm	
3	2 Points	1089.51	µm	
4	2 Points	1057.2	µm	
5	2 Points	1080.54	µm	
	Average	1076.48		-0.89
	Standard Deviation (σ)	11.96		
	% Relative Standard Deviation (%RSD)	1.11		
6	2 Points	1194.69	µm	
7	2 Points	1209.91	µm	
8	2 Points	1211.63	µm	
9	2 Points	1221.87	µm	
10	2 Points	1206.69	µm	
	Average	1208.96		0.39
	Standard Deviation (σ)	9.79		
	% Relative Standard Deviation (%RSD)	0.81		
11	2 Points	1131	µm	
12	2 Points	1147.77	µm	
13	2 Points	1151.29	µm	
14	2 Points	1133.57	µm	
15	2 Points	1155.53	µm	
	Average	1143.83		-0.72
	Standard Deviation (σ)	10.93		
	% Relative Standard Deviation (%RSD)	0.96		
16	2 Points	1175.37	µm	
17	2 Points	1173.56	µm	
18	2 Points	1194.03	µm	
19	2 Points	1180.01	µm	
20	2 Points	1170.65	µm	
	Average	1178.72		1.13
	Standard Deviation (σ)	9.21		
	% Relative Standard Deviation (%RSD)	0.78		
21	2 Points	1266.08	µm	
22	2 Points	1253.78	µm	
23	2 Points	1260	µm	
24	2 Points	1260	µm	
25	2 Points	1260	µm	
	Average	1259.97		1.44
	Standard Deviation (σ)	4.35		
	% Relative Standard Deviation (%RSD)	0.35		
26	2 Points	1111.26	µm	
27	2 Points	1117.48	µm	
28	2 Points	1119.41	µm	
29	2 Points	1111.52	µm	
30	2 Points	1115.87	µm	
	Average	1115.11		1.78
	Standard Deviation (σ)	3.62		
	% Relative Standard Deviation (%RSD)	0.32		
31	2 Points	1015.4	µm	
32	2 Points	1023.65	µm	
33	2 Points	1023.65	µm	
34	2 Points	1033.72	µm	
35	2 Points	1041.93	µm	

	Average	1008.27	
	Standard Deviation (σ)	5.10	
	% Relative Standard Deviation (%RSD)	0.51	
36	2 Points	1126.22	µm
37	2 Points	1133.64	µm
38	2 Points	1132.71	µm
39	2 Points	1133.6	µm
40	2 Points	1129.62	µm
	Average	1131.16	
	Standard Deviation (σ)	3.21	
	% Relative Standard Deviation (%RSD)	0.28	
41	2 Points	1119.76	µm
42	2 Points	1132.19	µm
43	2 Points	1133.21	µm
44	2 Points	1127.13	µm
45	2 Points	1124.04	µm
	Average	1127.27	
	Standard Deviation (σ)	5.62	
	% Relative Standard Deviation (%RSD)	0.50	
46	2 Points	1141.5	µm
47	2 Points	1128.33	µm
48	2 Points	1128.12	µm
49	2 Points	1124.53	µm
50	2 Points	1126.71	µm
	Average	1129.84	
	Standard Deviation (σ)	6.69	
	% Relative Standard Deviation (%RSD)	0.59	

	Average	1019.94	
	Standard Deviation (σ)	2.30	
	% Relative Standard Deviation (%RSD)	0.23	
36	2 Points	1155.18	µm
37	2 Points	1162.84	µm
38	2 Points	1150.94	µm
39	2 Points	1160.85	µm
40	2 Points	1159.01	µm
	Average	1157.76	
	Standard Deviation (σ)	4.75	
	% Relative Standard Deviation (%RSD)	0.41	
41	2 Points	1126.4	µm
42	2 Points	1136.92	µm
43	2 Points	1131.47	µm
44	2 Points	1145.44	µm
45	2 Points	1130.42	µm
	Average	1134.13	
	Standard Deviation (σ)	7.35	
	% Relative Standard Deviation (%RSD)	0.65	
46	2 Points	1127.95	µm
47	2 Points	1141.4	µm
48	2 Points	1129.51	µm
49	2 Points	1125.89	µm
50	2 Points	1130.55	µm
	Average	1131.06	
	Standard Deviation (σ)	6.04	
	% Relative Standard Deviation (%RSD)	0.53	

	Average	1027.67		1.92
	Standard Deviation (σ)	10.28		
	% Relative Standard Deviation (%RSD)	1.00		
36	2 Points	1141.67	µm	
37	2 Points	1150.52	µm	
38	2 Points	1160.62	µm	
39	2 Points	1149.19	µm	
40	2 Points	1138.07	µm	
	Average	1148.01		1.49
	Standard Deviation (σ)	8.74		
	% Relative Standard Deviation (%RSD)	0.76		
41	2 Points	1143.84	µm	
42	2 Points	1121.54	µm	
43	2 Points	1152.21	µm	
44	2 Points	1110.63	µm	
45	2 Points	1147.54	µm	
	Average	1135.15		0.70
	Standard Deviation (σ)	18.07		
	% Relative Standard Deviation (%RSD)	1.59		
46	2 Points	1144.72	µm	
47	2 Points	1151.01	µm	
48	2 Points	1151.68	µm	
49	2 Points	1151.01	µm	
50	2 Points	1132.11	µm	
	Average	1146.11		1.44
	Standard Deviation (σ)	8.32		
	% Relative Standard Deviation (%RSD)	0.73		
	Average % change			0.87

Spruce root basketry 5 (30:70 water:ethanol) - Width of elements before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	3/1/2017	2:18 PM	
No.	Measure	Result	Unit
1	2 Points	1006.33	µm
2	2 Points	982.33	µm
3	2 Points	987.46	µm
4	2 Points	982.28	µm
5	2 Points	988.67	µm
	Average (mean)	989.41	
	Standard Deviation (σ)	9.89	
	% Relative Standard Deviation (%RSD)	1.00	
6	2 Points	1279.66	µm
7	2 Points	1285.32	µm
8	2 Points	1291.63	µm
9	2 Points	1276.68	µm
10	2 Points	1288.61	µm
	Average (mean)	1284.38	
	Standard Deviation (σ)	6.18	
	% Relative Standard Deviation (%RSD)	0.48	
11	2 Points	898.85	µm
12	2 Points	898.21	µm
13	2 Points	891.58	µm
14	2 Points	896.65	µm
15	2 Points	905.35	µm
	Average (mean)	898.13	
	Standard Deviation (σ)	4.94	
	% Relative Standard Deviation (%RSD)	0.55	
16	2 Points	1169.37	µm
17	2 Points	1173.79	µm
18	2 Points	1187.18	µm
19	2 Points	1185.33	µm
20	2 Points	1169.86	µm
	Average (mean)	1177.11	
	Standard Deviation (σ)	8.55	
	% Relative Standard Deviation (%RSD)	0.73	
21	2 Points	1091.6	µm
22	2 Points	1117.28	µm
23	2 Points	1102.94	µm
24	2 Points	1119.49	µm
25	2 Points	1116.39	µm
	Average (mean)	1109.54	
	Standard Deviation (σ)	11.95	
	% Relative Standard Deviation (%RSD)	1.08	
26	2 Points	999.19	µm
27	2 Points	1014.27	µm
28	2 Points	1000.76	µm
29	2 Points	1001.14	µm
30	2 Points	1007.97	µm
	Average (mean)	1004.67	
	Standard Deviation (σ)	6.34	
	% Relative Standard Deviation (%RSD)	0.63	
31	2 Points	863.43	µm
32	2 Points	864.24	µm
33	2 Points	862.4	µm
34	2 Points	870.75	µm
35	2 Points	866.82	µm

During treatment

Title	Measurement Result		
Date saved	4/10/2017	1:47 PM	
No.	Measure	Result	Unit
1	2 Points	996.15	µm
2	2 Points	1011.43	µm
3	2 Points	1003.94	µm
4	2 Points	1002.39	µm
5	2 Points	1006.43	µm
	Average (mean)	1004.07	
	Standard Deviation (σ)	5.60	
	% Relative Standard Deviation (%RSD)	0.56	
6	2 Points	1312.56	µm
7	2 Points	1307.72	µm
8	2 Points	1312.44	µm
9	2 Points	1308.02	µm
10	2 Points	1307.55	µm
	Average (mean)	1309.66	
	Standard Deviation (σ)	2.60	
	% Relative Standard Deviation (%RSD)	0.20	
11	2 Points	906.31	µm
12	2 Points	912.1	µm
13	2 Points	905.61	µm
14	2 Points	908.51	µm
15	2 Points	911.69	µm
	Average (mean)	908.84	
	Standard Deviation (σ)	2.99	
	% Relative Standard Deviation (%RSD)	0.33	
16	2 Points	1204.96	µm
17	2 Points	1183.37	µm
18	2 Points	1185.43	µm
19	2 Points	1195.87	µm
20	2 Points	1196.58	µm
	Average (mean)	1193.24	
	Standard Deviation (σ)	8.86	
	% Relative Standard Deviation (%RSD)	0.74	
21	2 Points	1122.13	µm
22	2 Points	1105.53	µm
23	2 Points	1101.31	µm
24	2 Points	1111.84	µm
25	2 Points	1113.68	µm
	Average (mean)	1110.90	
	Standard Deviation (σ)	7.99	
	% Relative Standard Deviation (%RSD)	0.72	
26	2 Points	1022.61	µm
27	2 Points	1026.27	µm
28	2 Points	1017	µm
29	2 Points	1028.69	µm
30	2 Points	1019.29	µm
	Average (mean)	1022.77	
	Standard Deviation (σ)	4.81	
	% Relative Standard Deviation (%RSD)	0.47	
31	2 Points	861.04	µm
32	2 Points	870.7	µm
33	2 Points	875.25	µm
34	2 Points	862.37	µm
35	2 Points	871.13	µm

After treatment

Title	Measurement Result			
Date saved	4/14/2017	12:09 PM		
No.	Measure	Result	Unit	% Change (µm)
1	2 Points	1012.17	µm	
2	2 Points	999.79	µm	
3	2 Points	992.12	µm	
4	2 Points	993.6	µm	
5	2 Points	986.91	µm	
	Average (mean)	996.92		0.76
	Standard Deviation (σ)	9.68		
	% Relative Standard Deviation (%RSD)	0.97		
6	2 Points	1294.3	µm	
7	2 Points	1268.73	µm	
8	2 Points	1281.23	µm	
9	2 Points	1278.68	µm	
10	2 Points	1274.12	µm	
	Average (mean)	1279.41		-0.39
	Standard Deviation (σ)	9.59		
	% Relative Standard Deviation (%RSD)	0.75		
11	2 Points	899.69	µm	
12	2 Points	892.03	µm	
13	2 Points	895.46	µm	
14	2 Points	889.38	µm	
15	2 Points	897.87	µm	
	Average (mean)	894.89		-0.36
	Standard Deviation (σ)	4.21		
	% Relative Standard Deviation (%RSD)	0.47		
16	2 Points	1210.62	µm	
17	2 Points	1184.74	µm	
18	2 Points	1202.03	µm	
19	2 Points	1199.36	µm	
20	2 Points	1187.78	µm	
	Average (mean)	1196.91		1.68
	Standard Deviation (σ)	10.63		
	% Relative Standard Deviation (%RSD)	0.89		
21	2 Points	1116.25	µm	
22	2 Points	1092.37	µm	
23	2 Points	1100.82	µm	
24	2 Points	1101.48	µm	
25	2 Points	1104.02	µm	
	Average (mean)	1102.99		-0.59
	Standard Deviation (σ)	8.61		
	% Relative Standard Deviation (%RSD)	0.78		
26	2 Points	1024.82	µm	
27	2 Points	1024.15	µm	
28	2 Points	1010.85	µm	
29	2 Points	1016.6	µm	
30	2 Points	1016.6	µm	
	Average (mean)	1018.60		1.39
	Standard Deviation (σ)	5.86		
	% Relative Standard Deviation (%RSD)	0.58		
31	2 Points	895.78	µm	
32	2 Points	884.97	µm	
33	2 Points	863.92	µm	
34	2 Points	876.95	µm	
35	2 Points	875.57	µm	

	Average (mean)	865.53	
	Standard Deviation (σ)	3.35	
	% Relative Standard Deviation (%RSD)	0.39	
36	2 Points	906.55	µm
37	2 Points	912.74	µm
38	2 Points	906.68	µm
39	2 Points	916.66	µm
40	2 Points	905.48	µm
	Average (mean)	909.62	
	Standard Deviation (σ)	4.86	
	% Relative Standard Deviation (%RSD)	0.53	
41	2 Points	1055.68	µm
42	2 Points	1057.94	µm
43	2 Points	1044.59	µm
44	2 Points	1052.45	µm
45	2 Points	1051.33	µm
	Average (mean)	1052.40	
	Standard Deviation (σ)	5.09	
	% Relative Standard Deviation (%RSD)	0.48	
46	2 Points	1086.54	µm
47	2 Points	1088.76	µm
48	2 Points	1091.91	µm
49	2 Points	1083.3	µm
50	2 Points	1088.7	µm
	Average (mean)	1087.84	
	Standard Deviation (σ)	3.18	
	% Relative Standard Deviation (%RSD)	0.29	

	Average (mean)	868.10	
	Standard Deviation (σ)	6.12	
	% Relative Standard Deviation (%RSD)	0.70	
36	2 Points	917.91	µm
37	2 Points	898.85	µm
38	2 Points	931.85	µm
39	2 Points	908.17	µm
40	2 Points	930.41	µm
	Average (mean)	917.44	
	Standard Deviation (σ)	14.21	
	% Relative Standard Deviation (%RSD)	1.55	
41	2 Points	1072.19	µm
42	2 Points	1059.42	µm
43	2 Points	1068.3	µm
44	2 Points	1081.26	µm
45	2 Points	1076.1	µm
	Average (mean)	1071.45	
	Standard Deviation (σ)	8.26	
	% Relative Standard Deviation (%RSD)	0.77	
46	2 Points	1135.21	µm
47	2 Points	1109.02	µm
48	2 Points	1125	µm
49	2 Points	1128.12	µm
50	2 Points	1112.94	µm
	Average (mean)	1122.06	
	Standard Deviation (σ)	10.86	
	% Relative Standard Deviation (%RSD)	0.97	

	Average (mean)	879.44		1.61
	Standard Deviation (σ)	11.83		
	% Relative Standard Deviation (%RSD)	1.34		
36	2 Points	905.76	µm	
37	2 Points	900.31	µm	
38	2 Points	890.14	µm	
39	2 Points	892.53	µm	
40	2 Points	903.11	µm	
	Average (mean)	898.37		-1.24
	Standard Deviation (σ)	6.76		
	% Relative Standard Deviation (%RSD)	0.75		
41	2 Points	1025.93	µm	
42	2 Points	1036.71	µm	
43	2 Points	1038.24	µm	
44	2 Points	1041.31	µm	
45	2 Points	1024.7	µm	
	Average (mean)	1033.38		-1.81
	Standard Deviation (σ)	7.56		
	% Relative Standard Deviation (%RSD)	0.73		
46	2 Points	1105.17	µm	
47	2 Points	1091.42	µm	
48	2 Points	1121.07	µm	
49	2 Points	1105.93	µm	
50	2 Points	1097.87	µm	
	Average (mean)	1104.29		1.51
	Standard Deviation (σ)	11.09		
	% Relative Standard Deviation (%RSD)	1.00		
	Average % change			0.26

Spruce root basketry 6 (control) - Width of elements before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	3/1/2017	2:40 PM	
No.	**Measure**	**Result**	**Unit**
1	2 Points	998.19	µm
2	2 Points	999.64	µm
3	2 Points	998.94	µm
4	2 Points	1000.29	µm
5	2 Points	998.9	µm
	Average (mean)	999.19	
	Standard Deviation (σ)	0.80	
	% Relative Standard Deviation (%RSD)	0.08	
6	2 Points	923.03	µm
7	2 Points	925.45	µm
8	2 Points	924.99	µm
9	2 Points	917.74	µm
10	2 Points	922.87	µm
	Average (mean)	922.82	
	Standard Deviation (σ)	3.06	
	% Relative Standard Deviation (%RSD)	0.33	
11	2 Points	1229.28	µm
12	2 Points	1239.14	µm
13	2 Points	1250.18	µm
14	2 Points	1255.86	µm
15	2 Points	1239.35	µm
	Average (mean)	1242.76	
	Standard Deviation (σ)	10.41	
	% Relative Standard Deviation (%RSD)	0.84	
16	2 Points	1006.39	µm
17	2 Points	982.51	µm
18	2 Points	1004.5	µm
19	2 Points	993.76	µm
20	2 Points	996.55	µm
	Average (mean)	996.74	
	Standard Deviation (σ)	9.55	
	% Relative Standard Deviation (%RSD)	0.96	
21	2 Points	876.83	µm
22	2 Points	878.92	µm
23	2 Points	874.54	µm
24	2 Points	871.04	µm
25	2 Points	851.46	µm
	Average (mean)	870.56	
	Standard Deviation (σ)	11.07	
	% Relative Standard Deviation (%RSD)	1.27	
26	2 Points	1021.78	µm
27	2 Points	1037.18	µm
28	2 Points	1031.96	µm
29	2 Points	1015.16	µm
30	2 Points	1030.29	µm
	Average (mean)	1027.27	
	Standard Deviation (σ)	8.75	
	% Relative Standard Deviation (%RSD)	0.85	
31	2 Points	887.29	µm
32	2 Points	881	µm
33	2 Points	891.99	µm
34	2 Points	866.26	µm
35	2 Points	885.65	µm
	Average (mean)	882.44	

During treatment

Title	Measurement Result		
Date saved	4/10/2017	2:12 PM	
No.	Measure	Result	Unit
1	2 Points	1014.85	µm
2	2 Points	1017.96	µm
3	2 Points	1013.1	µm
4	2 Points	1013.73	µm
5	2 Points	1015.74	µm
	Average (mean)	1015.08	
	Standard Deviation (σ)	1.91	
	% Relative Standard Deviation (%RSD)	0.19	
6	2 Points	927.58	µm
7	2 Points	914.93	µm
8	2 Points	923.4	µm
9	2 Points	912.7	µm
10	2 Points	917.84	µm
	Average (mean)	919.29	
	Standard Deviation (σ)	6.13	
	% Relative Standard Deviation (%RSD)	0.67	
11	2 Points	1261.71	µm
12	2 Points	1248.69	µm
13	2 Points	1249.57	µm
14	2 Points	1247.35	µm
15	2 Points	1244.43	µm
	Average (mean)	1250.35	
	Standard Deviation (σ)	6.64	
	% Relative Standard Deviation (%RSD)	0.53	
16	2 Points	1021.65	µm
17	2 Points	1012.64	µm
18	2 Points	1010.32	µm
19	2 Points	995.74	µm
20	2 Points	1008.27	µm
	Average (mean)	1009.72	
	Standard Deviation (σ)	9.34	
	% Relative Standard Deviation (%RSD)	0.92	
21	2 Points	892.19	µm
22	2 Points	888.35	µm
23	2 Points	882.14	µm
24	2 Points	897.97	µm
25	2 Points	881.32	µm
	Average (mean)	888.39	
	Standard Deviation (σ)	6.99	
	% Relative Standard Deviation (%RSD)	0.79	
26	2 Points	1027.94	µm
27	2 Points	1014.85	µm
28	2 Points	1021.04	µm
29	2 Points	1015.45	µm
30	2 Points	1018.99	µm
	Average (mean)	1019.65	
	Standard Deviation (σ)	5.29	
	% Relative Standard Deviation (%RSD)	0.52	
31	2 Points	876.96	µm
32	2 Points	879.23	µm
33	2 Points	876.7	µm
34	2 Points	868.11	µm
35	2 Points	870.4	µm
	Average (mean)	874.28	

After treatment

Title	Measurement Result			
Date saved	4/14/2017	12:29 PM		
No.	Measure	Result	Unit	% Change (µm)
1	2 Points	1000.81	µm	
2	2 Points	1001.15	µm	
3	2 Points	1004.48	µm	
4	2 Points	1003.25	µm	
5	2 Points	1009.5	µm	
	Average (mean)	1003.84		0.46
	Standard Deviation (σ)	3.51		
	% Relative Standard Deviation (%RSD)	0.35		
6	2 Points	932.18	µm	
7	2 Points	932.37	µm	
8	2 Points	924.13	µm	
9	2 Points	924.13	µm	
10	2 Points	924.13	µm	
	Average (mean)	927.39		0.50
	Standard Deviation (σ)	4.46		
	% Relative Standard Deviation (%RSD)	0.48		
11	2 Points	1237.47	µm	
12	2 Points	1231.11	µm	
13	2 Points	1225.57	µm	
14	2 Points	1218.79	µm	
15	2 Points	1225.72	µm	
	Average (mean)	1227.73		-1.21
	Standard Deviation (σ)	6.98		
	% Relative Standard Deviation (%RSD)	0.57		
16	2 Points	1004.61	µm	
17	2 Points	998.24	µm	
18	2 Points	988.25	µm	
19	2 Points	983.4	µm	
20	2 Points	992.09	µm	
	Average (mean)	993.32		-0.34
	Standard Deviation (σ)	8.33		
	% Relative Standard Deviation (%RSD)	0.84		
21	2 Points	892.15	µm	
22	2 Points	885.78	µm	
23	2 Points	888.17	µm	
24	2 Points	879.78	µm	
25	2 Points	900.63	µm	
	Average (mean)	889.30		2.15
	Standard Deviation (σ)	7.76		
	% Relative Standard Deviation (%RSD)	0.87		
26	2 Points	1037.19	µm	
27	2 Points	1024.83	µm	
28	2 Points	1024.17	µm	
29	2 Points	1023.66	µm	
30	2 Points	1016.91	µm	
	Average (mean)	1025.35		-0.19
	Standard Deviation (σ)	7.35		
	% Relative Standard Deviation (%RSD)	0.72		
31	2 Points	883.03	µm	
32	2 Points	885.13	µm	
33	2 Points	885.34	µm	
34	2 Points	885.22	µm	
35	2 Points	885.13	µm	
	Average (mean)	884.77		0.26

	Standard Deviation (σ)	9.86	
	% Relative Standard Deviation (%RSD)	1.12	
36	2 Points	1112.86	µm
37	2 Points	1138.19	µm
38	2 Points	1131.54	µm
39	2 Points	1116.59	µm
40	2 Points	1112.56	µm
	Average (mean)	1122.35	
	Standard Deviation (σ)	11.77	
	% Relative Standard Deviation (%RSD)	1.05	
41	2 Points	1118.63	µm
42	2 Points	1125.57	µm
43	2 Points	1148.34	µm
44	2 Points	1154.7	µm
45	2 Points	1163.18	µm
	Average (mean)	1142.08	
	Standard Deviation (σ)	19.15	
	% Relative Standard Deviation (%RSD)	1.68	
46	2 Points	1116.56	µm
47	2 Points	1116.8	µm
48	2 Points	1129.41	µm
49	2 Points	1112.27	µm
50	2 Points	1101.67	µm
	Average (mean)	1115.34	
	Standard Deviation (σ)	9.97	
	% Relative Standard Deviation (%RSD)	0.89	

	Standard Deviation (σ)	4.76	
	% Relative Standard Deviation (%RSD)	0.54	
36	2 Points	1119.67	µm
37	2 Points	1120.88	µm
38	2 Points	1113.92	µm
39	2 Points	1105.68	µm
40	2 Points	1119.15	µm
	Average (mean)	1115.86	
	Standard Deviation (σ)	6.28	
	% Relative Standard Deviation (%RSD)	0.56	
41	2 Points	1128.27	µm
42	2 Points	1120.87	µm
43	2 Points	1130.53	µm
44	2 Points	1131.6	µm
45	2 Points	1134.32	µm
	Average (mean)	1129.12	
	Standard Deviation (σ)	5.10	
	% Relative Standard Deviation (%RSD)	0.45	
46	2 Points	1136.82	µm
47	2 Points	1127.59	µm
48	2 Points	1135.96	µm
49	2 Points	1127.43	µm
50	2 Points	1081.34	µm
	Average (mean)	1121.83	
	Standard Deviation (σ)	23.07	
	% Relative Standard Deviation (%RSD)	2.06	

	Standard Deviation (σ)	0.98		
	% Relative Standard Deviation (%RSD)	0.11		
36	2 Points	1095.34	µm	
37	2 Points	1099.53	µm	
38	2 Points	1112.4	µm	
39	2 Points	1118.62	µm	
40	2 Points	1105.87	µm	
	Average (mean)	1106.35		-1.43
	Standard Deviation (σ)	9.42		
	% Relative Standard Deviation (%RSD)	0.85		
41	2 Points	1150.52	µm	
42	2 Points	1137.6	µm	
43	2 Points	1123.1	µm	
44	2 Points	1140.26	µm	
45	2 Points	1124.99	µm	
	Average (mean)	1135.29		-0.59
	Standard Deviation (σ)	11.37		
	% Relative Standard Deviation (%RSD)	1.00		
46	2 Points	1112.3	µm	
47	2 Points	1117.23	µm	
48	2 Points	1102.15	µm	
49	2 Points	1116.42	µm	
50	2 Points	1097.54	µm	
	Average (mean)	1109.13		-0.56
	Standard Deviation (σ)	8.83		
	% Relative Standard Deviation (%RSD)	0.80		
	Average % change			-0.094

Spruce root basketry 1, cross section (water) - Width before, during and after treatment

Before treatment

Sample area	Title	Measurement Result		
	Date saved	6/12/2017	1:16 PM	
	No.	**Measure**	**Result**	**Unit**
Sample # 1 x-section	**1**	2 Points	1112.49	μm
	2	2 Points	1108.34	μm
	3	2 Points	1112.54	μm
	4	2 Points	1110.61	μm
	5	2 Points	1110.53	μm
	6	2 Points	1110.4	μm
	7	2 Points	1114.72	μm
	8	2 Points	1112.83	μm
	9	2 Points	1112.52	μm
	10	2 Points	1110.44	μm
		Average (mean)	1111.54	
		Standard Deviation (σ)	1.82	
		% Relative Standard Deviation (%RSD)	0.16	
Sample # 2 x-section	**11**	2 Points	1136.14	μm
	12	2 Points	1134.18	μm
	13	2 Points	1138.31	μm
	14	2 Points	1134.02	μm
	15	2 Points	1131.85	μm
	16	2 Points	1129.68	μm
	17	2 Points	1134.12	μm
	18	2 Points	1136.14	μm
	19	2 Points	1134.07	μm
	20	2 Points	1132	μm
		Average (mean)	1134.05	
		Standard Deviation (σ)	2.45	
		% Relative Standard Deviation (%RSD)	0.22	
Sample # 3 x-section	**21**	2 Points	1214.44	μm
	22	2 Points	1220.82	μm
	23	2 Points	1212.34	μm
	24	2 Points	1210.22	μm
	25	2 Points	1218.87	μm
	26	2 Points	1212.4	μm
	27	2 Points	1205.97	μm
	28	2 Points	1208.38	μm
	29	2 Points	1212.34	μm
	30	2 Points	1212.34	μm
		Average (mean)	1212.81	
		Standard Deviation (σ)	2.97	
		% Relative Standard Deviation (%RSD)	0.24	
Sample # 4 x-section	**31**	2 Points	1367.67	μm
	32	2 Points	1357.21	μm
	33	2 Points	1361.4	μm
	34	2 Points	1363.38	μm
	35	2 Points	1369.58	μm
	36	2 Points	1363.3	μm
	37	2 Points	1368.01	μm
	38	2 Points	1365.82	μm
	39	2 Points	1359.33	μm
	40	2 Points	1365.55	μm
		Average (mean)	1364.13	
		Standard Deviation (σ)	3.29	
		% Relative Standard Deviation (%RSD)	0.24	

During treatment

Title	Measurement Result		
Date saved	6/15/2017	11:12 AM	
No.	**Measure**	**Result**	**Unit**
1	2 Points	1104.12	μm
2	2 Points	1099.87	μm
3	2 Points	1097.86	μm
4	2 Points	1101.99	μm
5	2 Points	1106.4	μm
6	2 Points	1099.99	μm
7	2 Points	1097.91	μm
8	2 Points	1100.26	μm
9	2 Points	1095.95	μm
10	2 Points	1102.52	μm
	Average (mean)	1100.69	
	Standard Deviation (σ)	2.50	
	% Relative Standard Deviation (%RSD)	0.23	
11	2 Points	1132.04	μm
12	2 Points	1121.38	μm
13	2 Points	1110.88	μm
14	2 Points	1114.73	μm
15	2 Points	1110.6	μm
16	2 Points	1115	μm
17	2 Points	1110.6	μm
18	2 Points	1108.4	μm
19	2 Points	1116.93	μm
20	2 Points	1114.85	μm
	Average (mean)	1115.54	
	Standard Deviation (σ)	3.52	
	% Relative Standard Deviation (%RSD)	0.32	
21	2 Points	1210.22	μm
22	2 Points	1203.85	μm
23	2 Points	1201.77	μm
24	2 Points	1208.14	μm
25	2 Points	1203.82	μm
26	2 Points	1201.7	μm
27	2 Points	1195.31	μm
28	2 Points	1199.59	μm
29	2 Points	1197.5	μm
30	2 Points	1197.45	μm
	Average (mean)	1201.94	
	Standard Deviation (σ)	2.43	
	% Relative Standard Deviation (%RSD)	0.20	
31	2 Points	1355.4	μm
32	2 Points	1352.8	μm
33	2 Points	1352.85	μm
34	2 Points	1361.05	μm
35	2 Points	1354.88	μm
36	2 Points	1359.22	μm
37	2 Points	1357.15	μm
38	2 Points	1356.89	μm
39	2 Points	1361.21	μm
40	2 Points	1357.15	μm
	Average (mean)	1356.86	
	Standard Deviation (σ)	1.87	
	% Relative Standard Deviation (%RSD)	0.14	

After treatment

Title	Measurement Result			
Date saved	6/19/2017	2:09 PM		
No.	**Measure**	**Result**	**Unit**	**% Change**
1	2 Points	1114.6	μm	
2	2 Points	1108.23	μm	
3	2 Points	1110.35	μm	
4	2 Points	1116.79	μm	
5	2 Points	1108.25	μm	
6	2 Points	1112.49	μm	
7	2 Points	1112.48	μm	
8	2 Points	1112.51	μm	
9	2 Points	1112.48	μm	
10	2 Points	1106.1	μm	
	Average (mean)	1111.43		**-0.01**
	Standard Deviation (σ)	2.86		
	% Relative Standard Deviation (%RSD)	0.26		
11	2 Points	1099.83	μm	
12	2 Points	1104.14	μm	
13	2 Points	1110.52	μm	
14	2 Points	1100.16	μm	
15	2 Points	1101.89	μm	
16	2 Points	1106.12	μm	
17	2 Points	1114.62	μm	
18	2 Points	1108.3	μm	
19	2 Points	1108.25	μm	
20	2 Points	1114.63	μm	
	Average (mean)	1106.85		**-2.40**
	Standard Deviation (σ)	3.97		
	% Relative Standard Deviation (%RSD)	0.36		
21	2 Points	1188.98	μm	
22	2 Points	1199.57	μm	
23	2 Points	1201.79	μm	
24	2 Points	1197.43	μm	
25	2 Points	1193.33	μm	
26	2 Points	1199.62	μm	
27	2 Points	1193.25	μm	
28	2 Points	1193.33	μm	
29	2 Points	1193.21	μm	
30	2 Points	1195.3	μm	
	Average (mean)	1195.58		**-1.42**
	Standard Deviation (σ)	2.76		
	% Relative Standard Deviation (%RSD)	0.23		
31	2 Points	1336.08	μm	
32	2 Points	1340.21	μm	
33	2 Points	1336.15	μm	
34	2 Points	1340.01	μm	
35	2 Points	1325.47	μm	
36	2 Points	1333.73	μm	
37	2 Points	1348.55	μm	
38	2 Points	1342.33	μm	
39	2 Points	1346.42	μm	
40	2 Points	1333.78	μm	
	Average (mean)	1338.27		**-1.90**
	Standard Deviation (σ)	6.95		
	% Relative Standard Deviation (%RSD)	0.52		
	Average % Change			-1.43

Spruce root basketry 2, cross section (ethanol)
- Width before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	6/12/2017	1:31 PM	
No.	**Measure**	**Result**	**Unit**
1	2 Points	1284.72	µm
2	2 Points	1288.97	µm
3	2 Points	1282.6	µm
4	2 Points	1282.61	µm
5	2 Points	1280.48	µm
6	2 Points	1286.86	µm
7	2 Points	1280.52	µm
8	2 Points	1284.75	µm
9	2 Points	1286.85	µm
10	2 Points	1282.64	µm
	Average (mean)	1284.10	
	Standard Deviation (σ)	2.75	
	% Relative Standard Deviation (%RSD)	0.21	
11	2 Points	1269.86	µm
12	2 Points	1271.98	µm
13	2 Points	1271.98	µm
14	2 Points	1271.98	µm
15	2 Points	1276.25	µm
16	2 Points	1278.35	µm
17	2 Points	1280.48	µm
18	2 Points	1271.99	µm
19	2 Points	1265.61	µm
20	2 Points	1274.11	µm
	Average (mean)	1273.26	
	Standard Deviation (σ)	5.82	
	% Relative Standard Deviation (%RSD)	0.46	
21	2 Points	1214.64	µm
22	2 Points	1208.36	µm
23	2 Points	1206.14	µm
24	2 Points	1197.65	µm
25	2 Points	1210.42	µm
26	2 Points	1208.26	µm
27	2 Points	1204.02	µm
28	2 Points	1201.91	µm
29	2 Points	1201.89	µm
30	2 Points	1208.28	µm
	Average (mean)	1206.16	
	Standard Deviation (σ)	3.22	
	% Relative Standard Deviation (%RSD)	0.27	
31	2 Points	1434.29	µm
32	2 Points	1443.29	µm
33	2 Points	1443.48	µm
34	2 Points	1443.2	µm
35	2 Points	1436.49	µm
36	2 Points	1440.66	µm
37	2 Points	1446.96	µm
38	2 Points	1444.98	µm
39	2 Points	1445.23	µm
40	2 Points	1438.86	µm
	Average (mean)	1441.74	
	Standard Deviation (σ)	3.41	
	% Relative Standard Deviation (%RSD)	0.24	

During treatment

Title	Measurement Result		
Date saved	6/15/2017	11:26 AM	
No.	**Measure**	**Result**	**Unit**
1	2 Points	1276.1	µm
2	2 Points	1278.39	µm
3	2 Points	1284.63	µm
4	2 Points	1278.32	µm
5	2 Points	1282.52	µm
6	2 Points	1282.46	µm
7	2 Points	1276.13	µm
8	2 Points	1271.88	µm
9	2 Points	1276.09	µm
10	2 Points	1278.35	µm
	Average (mean)	1278.49	
	Standard Deviation (σ)	3.85	
	% Relative Standard Deviation (%RSD)	0.30	
11	2 Points	1257.84	µm
12	2 Points	1249.89	µm
13	2 Points	1258.48	µm
14	2 Points	1255.64	µm
15	2 Points	1236.78	µm
16	2 Points	1255.31	µm
17	2 Points	1264.06	µm
18	2 Points	1251.18	µm
19	2 Points	1259.96	µm
20	2 Points	1253.85	µm
	Average (mean)	1254.30	
	Standard Deviation (σ)	5.13	
	% Relative Standard Deviation (%RSD)	0.41	
21	2 Points	1212.74	µm
22	2 Points	1219.34	µm
23	2 Points	1221.28	µm
24	2 Points	1214.91	µm
25	2 Points	1219.16	µm
26	2 Points	1219.01	µm
27	2 Points	1218.89	µm
28	2 Points	1212.6	µm
29	2 Points	1219.01	µm
30	2 Points	1212.69	µm
	Average (mean)	1216.96	
	Standard Deviation (σ)	3.46	
	% Relative Standard Deviation (%RSD)	0.28	
31	2 Points	1412.47	µm
32	2 Points	1408.54	µm
33	2 Points	1422.99	µm
34	2 Points	1427.01	µm
35	2 Points	1420.63	µm
36	2 Points	1393.54	µm
37	2 Points	1420.91	µm
38	2 Points	1412.59	µm
39	2 Points	1420.63	µm
40	2 Points	1420.73	µm
	Average (mean)	1416.00	
	Standard Deviation (σ)	11.80	
	% Relative Standard Deviation (%RSD)	0.83	

After treatment

Title	Measurement Result			
Date saved	6/19/2017	2:24 PM		
No.	**Measure**	**Result**	**Unit**	**% Change**
1	2 Points	1272.09	µm	
2	2 Points	1276.41	µm	
3	2 Points	1267.86	µm	
4	2 Points	1272.08	µm	
5	2 Points	1270.04	µm	
6	2 Points	1270.04	µm	
7	2 Points	1270.07	µm	
8	2 Points	1267.91	µm	
9	2 Points	1265.93	µm	
10	2 Points	1265.93	µm	
	Average (mean)	1269.84		-1.11
	Standard Deviation (σ)	2.06		
	% Relative Standard Deviation (%RSD)	0.16		
11	2 Points	1280.54	µm	
12	2 Points	1276.3	µm	
13	2 Points	1284.79	µm	
14	2 Points	1280.56	µm	
15	2 Points	1274.17	µm	
16	2 Points	1284.79	µm	
17	2 Points	1286.96	µm	
18	2 Points	1284.81	µm	
19	2 Points	1284.79	µm	
20	2 Points	1284.79	µm	
	Average (mean)	1282.25		0.71
	Standard Deviation (σ)	0.97		
	% Relative Standard Deviation (%RSD)	0.08		
21	2 Points	1221.09	µm	
22	2 Points	1221.11	µm	
23	2 Points	1233.88	µm	
24	2 Points	1231.69	µm	
25	2 Points	1229.57	µm	
26	2 Points	1229.59	µm	
27	2 Points	1231.69	µm	
28	2 Points	1238.13	µm	
29	2 Points	1238.11	µm	
30	2 Points	1229.59	µm	
	Average (mean)	1230.45		2.01
	Standard Deviation (σ)	4.37		
	% Relative Standard Deviation (%RSD)	0.36		
31	2 Points	1412.63	µm	
32	2 Points	1416.93	µm	
33	2 Points	1417.1	µm	
34	2 Points	1410.73	µm	
35	2 Points	1423.47	µm	
36	2 Points	1423.03	µm	
37	2 Points	1421.17	µm	
38	2 Points	1414.8	µm	
39	2 Points	1423.6	µm	
40	2 Points	1429.4	µm	
	Average (mean)	1419.29		-1.56
	Standard Deviation (σ)	5.25		
	% Relative Standard Deviation (%RSD)	0.37		
	Average % Change			0.01

Spruce root basketry 3, cross section (70:30 water:ethanol) - Width before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	6/12/2017	1:41 PM	
No.	Measure	Result	Unit
1	2 Points	1293.13	µm
2	2 Points	1293.14	µm
3	2 Points	1297.51	µm
4	2 Points	1288.88	µm
5	2 Points	1291.02	µm
6	2 Points	1291.04	µm
7	2 Points	1297.46	µm
8	2 Points	1293.19	µm
9	2 Points	1293.15	µm
10	2 Points	1295.42	µm
	Average (mean)	1293.39	
	Standard Deviation (σ)	2.46	
	% Relative Standard Deviation (%RSD)	0.19	
11	2 Points	1212.51	µm
12	2 Points	1214.66	µm
13	2 Points	1206.17	µm
14	2 Points	1208.22	µm
15	2 Points	1214.69	µm
16	2 Points	1210.33	µm
17	2 Points	1210.31	µm
18	2 Points	1210.34	µm
19	2 Points	1214.66	µm
20	2 Points	1210.39	µm
	Average (mean)	1211.23	
	Standard Deviation (σ)	1.93	
	% Relative Standard Deviation (%RSD)	0.16	
21	2 Points	1210.3	µm
22	2 Points	1212.47	µm
23	2 Points	1203.94	µm
24	2 Points	1223.19	µm
25	2 Points	1212.43	µm
26	2 Points	1212.49	µm
27	2 Points	1216.73	µm
28	2 Points	1223.1	µm
29	2 Points	1212.44	µm
30	2 Points	1208.18	µm
	Average (mean)	1213.53	
	Standard Deviation (σ)	5.64	
	% Relative Standard Deviation (%RSD)	0.46	
31	2 Points	1133.85	µm
32	2 Points	1129.59	µm
33	2 Points	1148.72	µm
34	2 Points	1123.27	µm
35	2 Points	1138.1	µm
36	2 Points	1125.35	µm
37	2 Points	1131.72	µm
38	2 Points	1133.84	µm
39	2 Points	1138.09	µm
40	2 Points	1136.03	µm
	Average (mean)	1133.86	
	Standard Deviation (σ)	4.90	
	% Relative Standard Deviation (%RSD)	0.43	

During treatment

Title	Measurement Result		
Date saved	6/15/2017	11:42 AM	
No.	Measure	Result	Unit
1	2 Points	1287.38	µm
2	2 Points	1283.43	µm
3	2 Points	1289.57	µm
4	2 Points	1274.71	µm
5	2 Points	1283	µm
6	2 Points	1283.43	µm
7	2 Points	1296.16	µm
8	2 Points	1283	µm
9	2 Points	1286.96	µm
10	2 Points	1289.37	µm
	Average (mean)	1285.70	
	Standard Deviation (σ)	5.37	
	% Relative Standard Deviation (%RSD)	0.42	
11	2 Points	1229.55	µm
12	2 Points	1240.17	µm
13	2 Points	1235.89	µm
14	2 Points	1246.51	µm
15	2 Points	1240.07	µm
16	2 Points	1212.5	µm
17	2 Points	1227.5	µm
18	2 Points	1203.98	µm
19	2 Points	1220.95	µm
20	2 Points	1210.3	µm
	Average (mean)	1226.74	
	Standard Deviation (σ)	9.24	
	% Relative Standard Deviation (%RSD)	0.75	
21	2 Points	1231.61	µm
22	2 Points	1227.29	µm
23	2 Points	1223.25	µm
24	2 Points	1229.52	µm
25	2 Points	1227.5	µm
26	2 Points	1240.24	µm
27	2 Points	1235.82	µm
28	2 Points	1240.07	µm
29	2 Points	1238.04	µm
30	2 Points	1231.67	µm
	Average (mean)	1232.50	
	Standard Deviation (σ)	3.56	
	% Relative Standard Deviation (%RSD)	0.29	
31	2 Points	1155.07	µm
32	2 Points	1146.59	µm
33	2 Points	1150.82	µm
34	2 Points	1148.71	µm
35	2 Points	1135.96	µm
36	2 Points	1152.94	µm
37	2 Points	1146.58	µm
38	2 Points	1146.57	µm
39	2 Points	1140.2	µm
40	2 Points	1152.98	µm
	Average (mean)	1147.64	
	Standard Deviation (σ)	5.34	
	% Relative Standard Deviation (%RSD)	0.47	

After treatment

Title	Measurement Result			
Date saved	6/19/2017	2:37 PM		
No.	**Measure**	**Result**	**Unit**	**% Change**
1	2 Points	1289.33	µm	
2	2 Points	1285.31	µm	
3	2 Points	1280.84	µm	
4	2 Points	1293.63	µm	
5	2 Points	1285.04	µm	
6	2 Points	1285.14	µm	
7	2 Points	1285.31	µm	
8	2 Points	1289.38	µm	
9	2 Points	1285.14	µm	
10	2 Points	1289.05	µm	
	Average (mean)	1286.82		-0.51
	Standard Deviation (σ)	2.21		
	% Relative Standard Deviation (%RSD)	0.17		
11	2 Points	1221.09	µm	
12	2 Points	1214.72	µm	
13	2 Points	1221.04	µm	
14	2 Points	1227.47	µm	
15	2 Points	1214.66	µm	
16	2 Points	1210.41	µm	
17	2 Points	1210.41	µm	
18	2 Points	1212.68	µm	
19	2 Points	1212.58	µm	
20	2 Points	1214.72	µm	
	Average (mean)	1215.98		0.39
	Standard Deviation (σ)	1.81		
	% Relative Standard Deviation (%RSD)	0.15		
21	2 Points	1191.3	µm	
22	2 Points	1187.06	µm	
23	2 Points	1199.8	µm	
24	2 Points	1193.51	µm	
25	2 Points	1195.57	µm	
26	2 Points	1199.88	µm	
27	2 Points	1201.93	µm	
28	2 Points	1191.31	µm	
29	2 Points	1193.49	µm	
30	2 Points	1180.91	µm	
	Average (mean)	1193.48		-1.65
	Standard Deviation (σ)	8.29		
	% Relative Standard Deviation (%RSD)	0.69		
31	2 Points	1145.01	µm	
32	2 Points	1153.51	µm	
33	2 Points	1144.81	µm	
34	2 Points	1153.51	µm	
35	2 Points	1140.48	µm	
36	2 Points	1148.94	µm	
37	2 Points	1159.67	µm	
38	2 Points	1142.73	µm	
39	2 Points	1142.78	µm	
40	2 Points	1146.71	µm	
	Average (mean)	1147.82		1.23
	Standard Deviation (σ)	6.96		
	% Relative Standard Deviation (%RSD)	0.61		
	Average % Change			-0.13

Spruce root basketry 4, cross section (50:50 water:ethanol) - Width before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	6/12/2017	1:56 PM	
No.	Measure	Result	Unit
1	2 Points	1174.29	µm
2	2 Points	1170.02	µm
3	2 Points	1174.19	µm
4	2 Points	1169.91	µm
5	2 Points	1169.94	µm
6	2 Points	1163.55	µm
7	2 Points	1172.09	µm
8	2 Points	1172.14	µm
9	2 Points	1163.54	µm
10	2 Points	1157.25	µm
	Average (mean)	1168.69	
	Standard Deviation (σ)	6.38	
	% Relative Standard Deviation (%RSD)	0.55	
11	2 Points	1244.26	µm
12	2 Points	1242.19	µm
13	2 Points	1242.12	µm
14	2 Points	1235.74	µm
15	2 Points	1237.82	µm
16	2 Points	1239.95	µm
17	2 Points	1244.2	µm
18	2 Points	1239.95	µm
19	2 Points	1233.57	µm
20	2 Points	1239.95	µm
	Average (mean)	1239.98	
	Standard Deviation (σ)	3.80	
	% Relative Standard Deviation (%RSD)	0.31	
21	2 Points	1140.13	µm
22	2 Points	1144.38	µm
23	2 Points	1146.52	µm
24	2 Points	1146.51	µm
25	2 Points	1144.39	µm
26	2 Points	1142.25	µm
27	2 Points	1142.27	µm
28	2 Points	1138.03	µm
29	2 Points	1140.22	µm
30	2 Points	1140.37	µm
	Average (mean)	1142.51	
	Standard Deviation (σ)	1.75	
	% Relative Standard Deviation (%RSD)	0.15	
31	2 Points	1114.66	µm
32	2 Points	1116.82	µm
33	2 Points	1118.91	µm
34	2 Points	1118.91	µm
35	2 Points	1116.76	µm
36	2 Points	1118.89	µm
37	2 Points	1112.52	µm
38	2 Points	1121.01	µm
39	2 Points	1121.01	µm
40	2 Points	1114.65	µm
	Average (mean)	1117.41	
	Standard Deviation (σ)	3.85	
	% Relative Standard Deviation (%RSD)	0.34	

During treatment

Title	Measurement Result		
Date saved	6/15/2017	11:58 AM	
No.	Measure	Result	Unit
1	2 Points	1170.54	µm
2	2 Points	1168.41	µm
3	2 Points	1176.78	µm
4	2 Points	1166.11	µm
5	2 Points	1176.51	µm
6	2 Points	1174.42	µm
7	2 Points	1170.6	µm
8	2 Points	1179.03	µm
9	2 Points	1161.53	µm
10	2 Points	1161.58	µm
	Average (mean)	1170.55	
	Standard Deviation (σ)	7.79	
	% Relative Standard Deviation (%RSD)	0.67	
11	2 Points	1189.22	µm
12	2 Points	1199.73	µm
13	2 Points	1178.51	µm
14	2 Points	1189.28	µm
15	2 Points	1185.04	µm
16	2 Points	1185.04	µm
17	2 Points	1193.53	µm
18	2 Points	1197.78	µm
19	2 Points	1191.31	µm
20	2 Points	1199.87	µm
	Average (mean)	1190.93	
	Standard Deviation (σ)	5.82	
	% Relative Standard Deviation (%RSD)	0.49	
21	2 Points	1153.62	µm
22	2 Points	1138.51	µm
23	2 Points	1138.36	µm
24	2 Points	1142.42	µm
25	2 Points	1146.62	µm
26	2 Points	1134.26	µm
27	2 Points	1134.26	µm
28	2 Points	1140.82	µm
29	2 Points	1131.95	µm
30	2 Points	1129.73	µm
	Average (mean)	1139.06	
	Standard Deviation (σ)	4.15	
	% Relative Standard Deviation (%RSD)	0.36	
31	2 Points	1115.42	µm
32	2 Points	1111.41	µm
33	2 Points	1144.94	µm
34	2 Points	1136.57	µm
35	2 Points	1125.58	µm
36	2 Points	1130.02	µm
37	2 Points	1125.48	µm
38	2 Points	1110.72	µm
39	2 Points	1140.63	µm
40	2 Points	1134.26	µm
	Average (mean)	1127.50	
	Standard Deviation (σ)	11.26	
	% Relative Standard Deviation (%RSD)	1.00	

After treatment

Title	Measurement Result			
Date saved	6/19/2017	2:49 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	1188.8	µm	
2	2 Points	1184.58	µm	
3	2 Points	1195.19	µm	
4	2 Points	1191.03	µm	
5	2 Points	1193.23	µm	
6	2 Points	1184.51	µm	
7	2 Points	1182.47	µm	
8	2 Points	1182.4	µm	
9	2 Points	1180.31	µm	
10	2 Points	1184.54	µm	
	Average (mean)	1186.71		1.54
	Standard Deviation (σ)	1.76		
	% Relative Standard Deviation (%RSD)	0.15		
11	2 Points	1227.14	µm	
12	2 Points	1218.6	µm	
13	2 Points	1229.13	µm	
14	2 Points	1227.21	µm	
15	2 Points	1231.78	µm	
16	2 Points	1233.67	µm	
17	2 Points	1227.12	µm	
18	2 Points	1224.97	µm	
19	2 Points	1229.07	µm	
20	2 Points	1222.73	µm	
	Average (mean)	1227.14		-1.03
	Standard Deviation (σ)	4.18		
	% Relative Standard Deviation (%RSD)	0.34		
21	2 Points	1186.39	µm	
22	2 Points	1188.89	µm	
23	2 Points	1182.95	µm	
24	2 Points	1194.87	µm	
25	2 Points	1176.6	µm	
26	2 Points	1183.4	µm	
27	2 Points	1199.34	µm	
28	2 Points	1188.51	µm	
29	2 Points	1178.3	µm	
30	2 Points	1194.52	µm	
	Average (mean)	1187.38		3.93
	Standard Deviation (σ)	8.42		
	% Relative Standard Deviation (%RSD)	0.71		
31	2 Points	1157.4	µm	
32	2 Points	1169.73	µm	
33	2 Points	1169.82	µm	
34	2 Points	1172	µm	
35	2 Points	1161.73	µm	
36	2 Points	1159.12	µm	
37	2 Points	1152.64	µm	
38	2 Points	1163.45	µm	
39	2 Points	1165.6	µm	
40	2 Points	1152.61	µm	
	Average (mean)	1162.41		4.03
	Standard Deviation (σ)	6.00		
	% Relative Standard Deviation (%RSD)	0.52		
	Average % Change			2.12

Spruce root basketry 5, cross section (30:70 water:ethanol)
- Width before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	6/12/2017	2:08 PM	
No.	Measure	Result	Unit
1	2 Points	1276.24	µm
2	2 Points	1276.22	µm
3	2 Points	1278.35	µm
4	2 Points	1280.6	µm
5	2 Points	1282.67	µm
6	2 Points	1280.75	µm
7	2 Points	1280.8	µm
8	2 Points	1284.88	µm
9	2 Points	1280.75	µm
10	2 Points	1282.76	µm
	Average (mean)	1280.40	
	Standard Deviation (σ)	1.83	
	% Relative Standard Deviation (%RSD)	0.14	
11	2 Points	1214.62	µm
12	2 Points	1221.08	µm
13	2 Points	1225.24	µm
14	2 Points	1216.93	µm
15	2 Points	1218.89	µm
16	2 Points	1225.24	µm
17	2 Points	1214.63	µm
18	2 Points	1214.8	µm
19	2 Points	1220.99	µm
20	2 Points	1220.99	µm
	Average (mean)	1219.34	
	Standard Deviation (σ)	4.56	
	% Relative Standard Deviation (%RSD)	0.37	
21	2 Points	1168.09	µm
22	2 Points	1165.89	µm
23	2 Points	1170.09	µm
24	2 Points	1176.66	µm
25	2 Points	1164.03	µm
26	2 Points	1167.91	µm
27	2 Points	1164.03	µm
28	2 Points	1167.91	µm
29	2 Points	1159.47	µm
30	2 Points	1163.69	µm
	Average (mean)	1166.78	
	Standard Deviation (σ)	3.51	
	% Relative Standard Deviation (%RSD)	0.30	
31	2 Points	1057.76	µm
32	2 Points	1057.49	µm
33	2 Points	1065.98	µm
34	2 Points	1066.16	µm
35	2 Points	1066.31	µm
36	2 Points	1059.75	µm
37	2 Points	1059.63	µm
38	2 Points	1061.87	µm
39	2 Points	1057.67	µm
40	2 Points	1062.06	µm
	Average (mean)	1061.47	
	Standard Deviation (σ)	1.81	
	% Relative Standard Deviation (%RSD)	0.17	

During treatment

Title	Measurement Result		
Date saved	6/15/2017	12:10 PM	
No.	Measure	Result	Unit
1	2 Points	1257.54	µm
2	2 Points	1253.09	µm
3	2 Points	1253.09	µm
4	2 Points	1266.09	µm
5	2 Points	1246.98	µm
6	2 Points	1272.31	µm
7	2 Points	1253.2	µm
8	2 Points	1259.53	µm
9	2 Points	1261.84	µm
10	2 Points	1276.56	µm
	Average (mean)	1260.02	
	Standard Deviation (σ)	9.56	
	% Relative Standard Deviation (%RSD)	0.76	
11	2 Points	1149.16	µm
12	2 Points	1151.38	µm
13	2 Points	1153.25	µm
14	2 Points	1147.03	µm
15	2 Points	1161.81	µm
16	2 Points	1149.66	µm
17	2 Points	1161.81	µm
18	2 Points	1157.37	µm
19	2 Points	1151.44	µm
20	2 Points	1144.75	µm
	Average (mean)	1152.77	
	Standard Deviation (σ)	6.68	
	% Relative Standard Deviation (%RSD)	0.58	
21	2 Points	1134.06	µm
22	2 Points	1134.03	µm
23	2 Points	1136.33	µm
24	2 Points	1136.2	µm
25	2 Points	1140.45	µm
26	2 Points	1134.29	µm
27	2 Points	1134.14	µm
28	2 Points	1132.13	µm
29	2 Points	1125.56	µm
30	2 Points	1127.84	µm
	Average (mean)	1133.50	
	Standard Deviation (σ)	3.92	
	% Relative Standard Deviation (%RSD)	0.35	
31	2 Points	1013.13	µm
32	2 Points	1019.4	µm
33	2 Points	1025.73	µm
34	2 Points	1019.43	µm
35	2 Points	1015.22	µm
36	2 Points	1019.46	µm
37	2 Points	1019.38	µm
38	2 Points	1017.23	µm
39	2 Points	1021.55	µm
40	2 Points	1015.22	µm
	Average (mean)	1018.58	
	Standard Deviation (σ)	2.42	
	% Relative Standard Deviation (%RSD)	0.24	

After Treatment

Title	Measurement Result			
Date saved	6/19/2017	3:00 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	1303.97	µm	
2	2 Points	1306.13	µm	
3	2 Points	1308.13	µm	
4	2 Points	1299.69	µm	
5	2 Points	1301.7	µm	
6	2 Points	1295.39	µm	
7	2 Points	1293.21	µm	
8	2 Points	1293.18	µm	
9	2 Points	1303.81	µm	
10	2 Points	1299.56	µm	
	Average (mean)	1300.48		1.57
	Standard Deviation (σ)	4.60		
	% Relative Standard Deviation (%RSD)	0.35		
11	2 Points	1172.09	µm	
12	2 Points	1169.39	µm	
13	2 Points	1167.26	µm	
14	2 Points	1162.81	µm	
15	2 Points	1169.73	µm	
16	2 Points	1170.96	µm	
17	2 Points	1169.73	µm	
18	2 Points	1163.74	µm	
19	2 Points	1161.76	µm	
20	2 Points	1169.85	µm	
	Average (mean)	1167.73		-4.23
	Standard Deviation (σ)	4.16		
	% Relative Standard Deviation (%RSD)	0.36		
21	2 Points	1147.14	µm	
22	2 Points	1149.14	µm	
23	2 Points	1144.9	µm	
24	2 Points	1146.87	µm	
25	2 Points	1144.9	µm	
26	2 Points	1144.71	µm	
27	2 Points	1140.42	µm	
28	2 Points	1136.09	µm	
29	2 Points	1145.02	µm	
30	2 Points	1136.09	µm	
	Average (mean)	1143.53		-1.99
	Standard Deviation (σ)	4.39		
	% Relative Standard Deviation (%RSD)	0.38		
31	2 Points	1032.38	µm	
32	2 Points	1030.46	µm	
33	2 Points	1036.46	µm	
34	2 Points	1036.37	µm	
35	2 Points	1021.44	µm	
36	2 Points	1023.67	µm	
37	2 Points	1023.51	µm	
38	2 Points	1034.44	µm	
39	2 Points	1025.84	µm	
40	2 Points	1030.09	µm	
	Average (mean)	1029.47		-3.01
	Standard Deviation (σ)	4.70		
	% Relative Standard Deviation (%RSD)	0.46		
	Average % Change			-1.92

Spruce root basketry 6, cross section (control)
- Width before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	6/12/2017	2:16 PM	
No.	Measure	Result	Unit
1	2 Points	1183.39	µm
2	2 Points	1179.22	µm
3	2 Points	1176.7	µm
4	2 Points	1176.76	µm
5	2 Points	1177.34	µm
6	2 Points	1177.02	µm
7	2 Points	1179.38	µm
8	2 Points	1176.95	µm
9	2 Points	1179	µm
10	2 Points	1179.07	µm
	Average (mean)	1178.48	
	Standard Deviation (σ)	1.19	
	% Relative Standard Deviation (%RSD)	0.10	
11	2 Points	1180.85	µm
12	2 Points	1180.81	µm
13	2 Points	1183.07	µm
14	2 Points	1183.25	µm
15	2 Points	1185.2	µm
16	2 Points	1185.25	µm
17	2 Points	1181.06	µm
18	2 Points	1183.19	µm
19	2 Points	1183.39	µm
20	2 Points	1183.07	µm
	Average (mean)	1182.91	
	Standard Deviation (σ)	1.49	
	% Relative Standard Deviation (%RSD)	0.13	
21	2 Points	1000.06	µm
22	2 Points	1000.23	µm
23	2 Points	995.92	µm
24	2 Points	1000.06	µm
25	2 Points	1002.32	µm
26	2 Points	996.03	µm
27	2 Points	998.15	µm
28	2 Points	998.11	µm
29	2 Points	998.25	µm
30	2 Points	995.95	µm
	Average (mean)	998.51	
	Standard Deviation (σ)	1.20	
	% Relative Standard Deviation (%RSD)	0.12	
31	2 Points	1004.41	µm
32	2 Points	1008.63	µm
33	2 Points	1012.8	µm
34	2 Points	1006.44	µm
35	2 Points	1004.3	µm
36	2 Points	1002.18	µm
37	2 Points	1008.57	µm
38	2 Points	1006.65	µm
39	2 Points	998.04	µm
40	2 Points	1006.48	µm
	Average (mean)	1005.85	
	Standard Deviation (σ)	4.25	
	% Relative Standard Deviation (%RSD)	0.42	

During treatment

Title	Measurement Result		
Date saved	6/15/2017	12:23 PM	
No.	Measure	Result	Unit
1	2 Points	1185.9	µm
2	2 Points	1189.9	µm
3	2 Points	1185.32	µm
4	2 Points	1194.22	µm
5	2 Points	1187.86	µm
6	2 Points	1188.3	µm
7	2 Points	1186.28	µm
8	2 Points	1188.11	µm
9	2 Points	1186.18	µm
10	2 Points	1192.45	µm
	Average (mean)	1188.45	
	Standard Deviation (σ)	2.54	
	% Relative Standard Deviation (%RSD)	0.21	
11	2 Points	1183.09	µm
12	2 Points	1172.59	µm
13	2 Points	1176.89	µm
14	2 Points	1172.53	µm
15	2 Points	1170.41	µm
16	2 Points	1183.26	µm
17	2 Points	1185.22	µm
18	2 Points	1172.48	µm
19	2 Points	1176.89	µm
20	2 Points	1181.49	µm
	Average (mean)	1177.49	
	Standard Deviation (σ)	5.15	
	% Relative Standard Deviation (%RSD)	0.44	
21	2 Points	1010.75	µm
22	2 Points	1015.07	µm
23	2 Points	1004.39	µm
24	2 Points	1015.13	µm
25	2 Points	1021.38	µm
26	2 Points	1021.54	µm
27	2 Points	1021.44	µm
28	2 Points	1017.26	µm
29	2 Points	1021.38	µm
30	2 Points	1004.55	µm
	Average (mean)	1015.29	
	Standard Deviation (σ)	7.32	
	% Relative Standard Deviation (%RSD)	0.72	
31	2 Points	983.17	µm
32	2 Points	991.77	µm
33	2 Points	987.38	µm
34	2 Points	998.06	µm
35	2 Points	1004.43	µm
36	2 Points	987.53	µm
37	2 Points	1004.39	µm
38	2 Points	993.81	µm
39	2 Points	1004.39	µm
40	2 Points	1011.01	µm
	Average (mean)	996.59	
	Standard Deviation (σ)	9.40	
	% Relative Standard Deviation (%RSD)	0.94	

After treatment

Title	Measurement Result			
Date saved	6/19/2017	3:12 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	1187.03	µm	
2	2 Points	1189.21	µm	
3	2 Points	1187	µm	
4	2 Points	1182.78	µm	
5	2 Points	1191.37	µm	
6	2 Points	1187.03	µm	
7	2 Points	1180.59	µm	
8	2 Points	1187.06	µm	
9	2 Points	1185.04	µm	
10	2 Points	1189.18	µm	
	Average (mean)	1186.63		0.69
	Standard Deviation (σ)	3.25		
	% Relative Standard Deviation (%RSD)	0.27		
11	2 Points	1172.19	µm	
12	2 Points	1174.47	µm	
13	2 Points	1167.98	µm	
14	2 Points	1172.14	µm	
15	2 Points	1172.16	µm	
16	2 Points	1172.3	µm	
17	2 Points	1159.6	µm	
18	2 Points	1163.67	µm	
19	2 Points	1178.47	µm	
20	2 Points	1170.38	µm	
	Average (mean)	1170.34		-1.06
	Standard Deviation (σ)	7.40		
	% Relative Standard Deviation (%RSD)	0.63		
21	2 Points	1029.81	µm	
22	2 Points	1021.28	µm	
23	2 Points	1021.31	µm	
24	2 Points	1021.33	µm	
25	2 Points	1021.45	µm	
26	2 Points	1021.38	µm	
27	2 Points	1029.81	µm	
28	2 Points	1029.81	µm	
29	2 Points	1036.32	µm	
30	2 Points	1025.63	µm	
	Average (mean)	1025.81		2.73
	Standard Deviation (σ)	5.56		
	% Relative Standard Deviation (%RSD)	0.54		
31	2 Points	968.41	µm	
32	2 Points	976.86	µm	
33	2 Points	981.37	µm	
34	2 Points	981.25	µm	
35	2 Points	976.86	µm	
36	2 Points	977.13	µm	
37	2 Points	985.62	µm	
38	2 Points	992.12	µm	
39	2 Points	981.75	µm	
40	2 Points	985.36	µm	
	Average (mean)	980.67		-2.50
	Standard Deviation (σ)	5.52		
	% Relative Standard Deviation (%RSD)	0.56		
	Average % Change			-0.04

Spruce root non-basketry 1 (control)
- Width before, during and after treatment

Before treatment

Title	Measurement Result			
Date saved	6/12/2017	2:29 PM		
No.	Measure	Result	Unit	
1	2 Points	2064.35	µm	
2	2 Points	2056.19	µm	
3	2 Points	2058.45	µm	
4	2 Points	2058.36	µm	
5	2 Points	2054.02	µm	
6	2 Points	2056.33	µm	
7	2 Points	2060.53	µm	
8	2 Points	2062.52	µm	
9	2 Points	2061.05	µm	
10	2 Points	2062.6	µm	
	Average (mean)	2059.44		
	Standard Deviation (σ)	3.32		
	% Relative Standard Deviation (%RSD)	0.16		
11	2 Points	2055.88	µm	
12	2 Points	2053.78	µm	
13	2 Points	2045.32	µm	
14	2 Points	2049.78	µm	
15	2 Points	2049.59	µm	
16	2 Points	2053.98	µm	
17	2 Points	2043.59	µm	
18	2 Points	2045.41	µm	
19	2 Points	2043.33	µm	
20	2 Points	2043.14	µm	
	Average (mean)	2048.38		
	Standard Deviation (σ)	4.88		
	% Relative Standard Deviation (%RSD)	0.24		
21	2 Points	2077.04	µm	
22	2 Points	2075.02	µm	
23	2 Points	2070.93	µm	
24	2 Points	2072.95	µm	
25	2 Points	2070.8	µm	
26	2 Points	2074.93	µm	
27	2 Points	2072.77	µm	
28	2 Points	2072.87	µm	
29	2 Points	2072.79	µm	
30	2 Points	2068.55	µm	
	Average (mean)	2072.87		
	Standard Deviation (σ)	2.43		
	% Relative Standard Deviation (%RSD)	0.12		
31	2 Points	2096.11	µm	
32	2 Points	2089.77	µm	
33	2 Points	2085.49	µm	
34	2 Points	2091.85	µm	
35	2 Points	2087.61	µm	
36	2 Points	2089.73	µm	
37	2 Points	2089.74	µm	
38	2 Points	2089.73	µm	
39	2 Points	2089.73	µm	
40	2 Points	2089.84	µm	
	Average (mean)	2089.96		
	Standard Deviation (σ)	2.73		
	% Relative Standard Deviation (%RSD)	0.13		
41	2 Points	2202.32	µm	
42	2 Points	2198.08	µm	
43	2 Points	2202.32	µm	
44	2 Points	2198.05	µm	
45	2 Points	2198.05	µm	
46	2 Points	2200.22	µm	

During treatment

Title	Measurement Result			
Date saved	6/15/2017	12:40 PM		
No.	Measure	Result	Unit	
1	2 Points	2064.26	µm	
2	2 Points	2062.17	µm	
3	2 Points	2068.38	µm	
4	2 Points	2066.42	µm	
5	2 Points	2062.17	µm	
6	2 Points	2057.97	µm	
7	2 Points	2066.38	µm	
8	2 Points	2062.26	µm	
9	2 Points	2070.75	µm	
10	2 Points	2060.01	µm	
	Average (mean)	2064.08		
	Standard Deviation (σ)	3.92		
	% Relative Standard Deviation (%RSD)	0.19		
11	2 Points	2057.61	µm	
12	2 Points	2046.99	µm	
13	2 Points	2051.27	µm	
14	2 Points	2059.74	µm	
15	2 Points	2053.38	µm	
16	2 Points	2051.24	µm	
17	2 Points	2049.13	µm	
18	2 Points	2055.52	µm	
19	2 Points	2049.17	µm	
20	2 Points	2051.22	µm	
	Average (mean)	2052.53		
	Standard Deviation (σ)	4.03		
	% Relative Standard Deviation (%RSD)	0.20		
21	2 Points	2068.26	µm	
22	2 Points	2063.97	µm	
23	2 Points	2063.95	µm	
24	2 Points	2063.96	µm	
25	2 Points	2072.48	µm	
26	2 Points	2072.47	µm	
27	2 Points	2080.94	µm	
28	2 Points	2078.83	µm	
29	2 Points	2085.19	µm	
30	2 Points	2078.82	µm	
	Average (mean)	2072.89		
	Standard Deviation (σ)	7.80		
	% Relative Standard Deviation (%RSD)	0.38		
31	2 Points	2091.56	µm	
32	2 Points	2091.58	µm	
33	2 Points	2087.39	µm	
34	2 Points	2080.95	µm	
35	2 Points	2087.31	µm	
36	2 Points	2085.18	µm	
37	2 Points	2076.74	µm	
38	2 Points	2076.71	µm	
39	2 Points	2080.97	µm	
40	2 Points	2080.97	µm	
	Average (mean)	2083.94		
	Standard Deviation (σ)	5.50		
	% Relative Standard Deviation (%RSD)	0.26		
41	2 Points	2193.5	µm	
42	2 Points	2206.24	µm	
43	2 Points	2202.02	µm	
44	2 Points	2206.27	µm	
45	2 Points	2202.01	µm	
46	2 Points	2195.62	µm	

After treatment

Title	Measurement Result			
Date saved	6/19/2017	3:24 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	2079.73	µm	
2	2 Points	2079.62	µm	
3	2 Points	2071.58	µm	
4	2 Points	2084.66	µm	
5	2 Points	2084.08	µm	
6	2 Points	2076.68	µm	
7	2 Points	2073.59	µm	
8	2 Points	2080.79	µm	
9	2 Points	2070.07	µm	
10	2 Points	2070.32	µm	
	Average (mean)	2077.11		0.86
	Standard Deviation (σ)	5.49		
	% Relative Standard Deviation (%RSD)	0.26		
11	2 Points	2062.66	µm	
12	2 Points	2062.66	µm	
13	2 Points	2060.43	µm	
14	2 Points	2063.1	µm	
15	2 Points	2062.88	µm	
16	2 Points	2060.43	µm	
17	2 Points	2065	µm	
18	2 Points	2063.1	µm	
19	2 Points	2071.94	µm	
20	2 Points	2056.29	µm	
	Average (mean)	2062.85		0.71
	Standard Deviation (σ)	3.97		
	% Relative Standard Deviation (%RSD)	0.19		
21	2 Points	2095.65	µm	
22	2 Points	2091.41	µm	
23	2 Points	2082.67	µm	
24	2 Points	2087.08	µm	
25	2 Points	2091.41	µm	
26	2 Points	2087	µm	
27	2 Points	2084.96	µm	
28	2 Points	2087.16	µm	
29	2 Points	2093.7	µm	
30	2 Points	2089.12	µm	
	Average (mean)	2089.02		0.78
	Standard Deviation (σ)	4.02		
	% Relative Standard Deviation (%RSD)	0.19		
31	2 Points	2092.36	µm	
32	2 Points	2094.4	µm	
33	2 Points	2088.16	µm	
34	2 Points	2083.87	µm	
35	2 Points	2094.53	µm	
36	2 Points	2098.65	µm	
37	2 Points	2090.16	µm	
38	2 Points	2090.29	µm	
39	2 Points	2088.16	µm	
40	2 Points	2094.32	µm	
	Average (mean)	2091.49		0.07
	Standard Deviation (σ)	4.23		
	% Relative Standard Deviation (%RSD)	0.20		
41	2 Points	2209.19	µm	
42	2 Points	2215.71	µm	
43	2 Points	2209.34	µm	
44	2 Points	2207.32	µm	
45	2 Points	2211.36	µm	
46	2 Points	2205.43	µm	

47	2 Points	2200.19	µm	
48	2 Points	2193.83	µm	
49	2 Points	2198.05	µm	
50	2 Points	2195.97	µm	
	Average (mean)	2198.71		
	Standard Deviation (σ)	2.66		
	% Relative Standard Deviation (%RSD)	0.12		

47	2 Points	2197.78	µm	
48	2 Points	2195.64	µm	
49	2 Points	2195.63	µm	
50	2 Points	2191.38	µm	
	Average (mean)	2198.61		
	Standard Deviation (σ)	5.23		
	% Relative Standard Deviation (%RSD)	0.24		

47	2 Points	2205.43	µm	
48	2 Points	2216.05	µm	
49	2 Points	2203.19	µm	
50	2 Points	2205.37	µm	
	Average (mean)	2208.84		**0.46**
	Standard Deviation (σ)	4.42		
	% Relative Standard Deviation (%RSD)	0.20		
	Average % change			0.58

Spruce root non-basketry 2 (water)
- Width before, during and after treatment

Before treatment

Spot on sample	Title	Measurement Result		
	Date saved	5/10/2017	2:03 PM	
	No.	Measure	Result	Unit
	1	2 Points	2925.3	µm
	2	2 Points	2929.66	µm
	3	2 Points	2925.26	µm
	4	2 Points	2933.85	µm
	5	2 Points	2933.71	µm
	6	2 Points	2933.86	µm
Spot # 1	7	2 Points	2933.8	µm
	8	2 Points	2929.94	µm
	9	2 Points	2929.63	µm
	10	2 Points	2935.99	µm
		Average (mean)	2931.10	
		Standard Deviation (σ)	3.75	
		% Relative Standard Deviation (%RSD)	0.13	
	11	2 Points	2857.26	µm
	12	2 Points	2853.01	µm
	13	2 Points	2857.35	µm
	14	2 Points	2855.18	µm
	15	2 Points	2857.35	µm
	16	2 Points	2855.21	µm
Spot # 2	17	2 Points	2859.46	µm
	18	2 Points	2853.01	µm
	19	2 Points	2855.13	µm
	20	2 Points	2859.43	µm
		Average (mean)	2856.24	
		Standard Deviation (σ)	2.32	
		% Relative Standard Deviation (%RSD)	0.08	
	21	2 Points	2833.92	µm
	22	2 Points	2850.89	µm
	23	2 Points	2838.29	µm
	24	2 Points	2846.63	µm
	25	2 Points	2838.22	µm
	26	2 Points	2840.27	µm
Spot # 3	27	2 Points	2844.57	µm
	28	2 Points	2846.61	µm
	29	2 Points	2831.8	µm
	30	2 Points	2842.42	µm
		Average (mean)	2841.36	
		Standard Deviation (σ)	6.01	
		% Relative Standard Deviation (%RSD)	0.21	
	31	2 Points	2844.87	µm
	32	2 Points	2852.75	µm
	33	2 Points	2839.16	µm
	34	2 Points	2847.38	µm
	35	2 Points	2853.62	µm
	36	2 Points	2847.84	µm
Spot # 4	37	2 Points	2862.12	µm
	38	2 Points	2851.5	µm
	39	2 Points	2855.93	µm
	40	2 Points	2846.95	µm
		Average (mean)	2850.21	
		Standard Deviation (σ)	6.40	

During treatment

Title	Measurement Result		
Date saved	5/16/2017	3:39 PM	
No.	Measure	Result	Unit
1	2 Points	2855.76	µm
2	2 Points	2861.74	µm
3	2 Points	2849.3	µm
4	2 Points	2859.83	µm
5	2 Points	2865.67	µm
6	2 Points	2855.1	µm
7	2 Points	2847.09	µm
8	2 Points	2855.54	µm
9	2 Points	2848.68	µm
10	2 Points	2855.06	µm
	Average (mean)	2855.38	
	Standard Deviation (σ)	5.94	
	% Relative Standard Deviation (%RSD)	0.21	
11	2 Points	2801.97	µm
12	2 Points	2808.34	µm
13	2 Points	2816.9	µm
14	2 Points	2823.2	µm
15	2 Points	2810.58	µm
16	2 Points	2812.58	µm
17	2 Points	2802.12	µm
18	2 Points	2808.6	µm
19	2 Points	2806.35	µm
20	2 Points	2802.26	µm
	Average (mean)	2809.29	
	Standard Deviation (σ)	6.90	
	% Relative Standard Deviation (%RSD)	0.25	
21	2 Points	2861.74	µm
22	2 Points	2874.78	µm
23	2 Points	2876.66	µm
24	2 Points	2870.09	µm
25	2 Points	2872.08	µm
26	2 Points	2885.27	µm
27	2 Points	2863.77	µm
28	2 Points	2881.66	µm
29	2 Points	2870.07	µm
30	2 Points	2881.6	µm
	Average (mean)	2873.77	
	Standard Deviation (σ)	7.75	
	% Relative Standard Deviation (%RSD)	0.27	
31	2 Points	2803.74	µm
32	2 Points	2810.76	µm
33	2 Points	2809.26	µm
34	2 Points	2793.7	µm
35	2 Points	2816.79	µm
36	2 Points	2809.1	µm
37	2 Points	2806.43	µm
38	2 Points	2814.75	µm
39	2 Points	2810.85	µm
40	2 Points	2816.87	µm
	Average (mean)	2809.23	
	Standard Deviation (σ)	6.91	

After treatment

Title	Measurement Result			
Date saved	5/18/2017	2:52 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	2845.67	µm	
2	2 Points	2845.45	µm	
3	2 Points	2850.11	µm	
4	2 Points	2847.86	µm	
5	2 Points	2850.11	µm	
6	2 Points	2841.2	µm	
7	2 Points	2853.37	µm	
8	2 Points	2841.25	µm	
9	2 Points	2845.34	µm	
10	2 Points	2845.61	µm	
	Average (mean)	2846.60		-2.88
	Standard Deviation (σ)	3.87		
	% Relative Standard Deviation (%RSD)	0.14		
11	2 Points	2794.02	µm	
12	2 Points	2798.39	µm	
13	2 Points	2798.39	µm	
14	2 Points	2800.52	µm	
15	2 Points	2795.97	µm	
16	2 Points	2802.41	µm	
17	2 Points	2794.28	µm	
18	2 Points	2796.31	µm	
19	2 Points	2800.36	µm	
20	2 Points	2800.32	µm	
	Average (mean)	2798.10		-2.04
	Standard Deviation (σ)	2.86		
	% Relative Standard Deviation (%RSD)	0.10		
21	2 Points	2842.41	µm	
22	2 Points	2833.92	µm	
23	2 Points	2842.45	µm	
24	2 Points	2831.83	µm	
25	2 Points	2840.32	µm	
26	2 Points	2825.53	µm	
27	2 Points	2832.04	µm	
28	2 Points	2846.65	µm	
29	2 Points	2840.29	µm	
30	2 Points	2842.41	µm	
	Average (mean)	2837.79		-0.13
	Standard Deviation (σ)	6.58		
	% Relative Standard Deviation (%RSD)	0.23		
31	2 Points	2861.65	µm	
32	2 Points	2863.82	µm	
33	2 Points	2870.09	µm	
34	2 Points	2861.63	µm	
35	2 Points	2874.55	µm	
36	2 Points	2878.62	µm	
37	2 Points	2868.01	µm	
38	2 Points	2867.92	µm	
39	2 Points	2876.39	µm	
40	2 Points	2870.08	µm	
	Average (mean)	2869.28		0.67
	Standard Deviation (σ)	5.93		

		% Relative Standard Deviation (%RSD)	0.22	
Spot # 5	**41**	2 Points	2798.98	µm
	42	2 Points	2794.26	µm
	43	2 Points	2792.22	µm
	44	2 Points	2803.56	µm
	45	2 Points	2794.99	µm
	46	2 Points	2802.45	µm
	47	2 Points	2796.18	µm
	48	2 Points	2796.84	µm
	49	2 Points	2773.55	µm
	50	2 Points	2800.78	µm
		Average (mean)	2795.38	
		Standard Deviation (σ)	8.50	
		% Relative Standard Deviation (%RSD)	0.30	

	% Relative Standard Deviation (%RSD)	0.25	
41	2 Points	2789.65	µm
42	2 Points	2822.98	µm
43	2 Points	2811.32	µm
44	2 Points	2806.43	µm
45	2 Points	2815.96	µm
46	2 Points	2806.85	µm
47	2 Points	2792.96	µm
48	2 Points	2796.47	µm
49	2 Points	2806.6	µm
50	2 Points	2815.18	µm
	Average (mean)	2806.44	
	Standard Deviation (σ)	10.69	
	% Relative Standard Deviation (%RSD)	0.38	

	% Relative Standard Deviation (%RSD)	0.21		
41	2 Points	2857.45	µm	
42	2 Points	2829.7	µm	
43	2 Points	2853.25	µm	
44	2 Points	2850.98	µm	
45	2 Points	2857.34	µm	
46	2 Points	2855.15	µm	
47	2 Points	2857.43	µm	
48	2 Points	2848.91	µm	
49	2 Points	2851.02	µm	
50	2 Points	2850.94	µm	
	Average (mean)	2851.22		2.00
	Standard Deviation (σ)	8.19		
	% Relative Standard Deviation (%RSD)	0.29		
	Average % change			-0.48

Spruce root non-basketry 3 (ethanol)
- Width before, during and after treatment

Before treatment

Title	Measurement Result			
Date saved	5/10/2017	2:20 PM		
No.	Measure	Result	Unit	
1	2 Points	2876.55	µm	
2	2 Points	2874.71	µm	
3	2 Points	2883.7	µm	
4	2 Points	2871	µm	
5	2 Points	2868.33	µm	
6	2 Points	2864.75	µm	
7	2 Points	2864.3	µm	
8	2 Points	2871.98	µm	
9	2 Points	2856.66	µm	
10	2 Points	2858.41	µm	
	Average (mean)	2869.04		
	Standard Deviation (σ)	8.32		
	% Relative Standard Deviation (RSD)	0.29		
11	2 Points	2772.27	µm	
12	2 Points	2774.57	µm	
13	2 Points	2776.5	µm	
14	2 Points	2776.21	µm	
15	2 Points	2783.72	µm	
16	2 Points	2783.21	µm	
17	2 Points	2778.16	µm	
18	2 Points	2779.83	µm	
19	2 Points	2776.21	µm	
20	2 Points	2773.49	µm	
	Average (mean)	2777.42		
	Standard Deviation (σ)	3.85		
	% Relative Standard Deviation (RSD)	0.14		
21	2 Points	2774.4	µm	
22	2 Points	2776.37	µm	
23	2 Points	2764.09	µm	
24	2 Points	2778.49	µm	
25	2 Points	2756.21	µm	
26	2 Points	2769.07	µm	
27	2 Points	2774.38	µm	
28	2 Points	2763.44	µm	
29	2 Points	2772.13	µm	
30	2 Points	2769.07	µm	
	Average (mean)	2769.77		
	Standard Deviation (σ)	6.87		
	% Relative Standard Deviation (RSD)	0.25		
31	2 Points	2783.01	µm	
32	2 Points	2779.49	µm	
33	2 Points	2774.83	µm	
34	2 Points	2781.43	µm	
35	2 Points	2775.73	µm	
36	2 Points	2774.38	µm	
37	2 Points	2779.97	µm	
38	2 Points	2772.3	µm	
39	2 Points	2779.84	µm	
40	2 Points	2773.31	µm	
	Average (mean)	2777.43		
	Standard Deviation (σ)	3.74		
	% Relative Standard Deviation (RSD)	0.13		
41	2 Points	2798.5	µm	
42	2 Points	2790.98	µm	
43	2 Points	2791.9	µm	
44	2 Points	2800.74	µm	
45	2 Points	2792.78	µm	
46	2 Points	2795.3	µm	
47	2 Points	2795.44	µm	
48	2 Points	2799.14	µm	
49	2 Points	2802.43	µm	
50	2 Points	2797.42	µm	
	Average (mean)	2796.46		
	Standard Deviation (σ)	3.84		
	% Relative Standard Deviation (RSD)	0.14		

During treatment

Title	Measurement Result			
Date saved	5/16/2017	4:13 PM		
No.	Measure	Result	Unit	
1	2 Points	2863.53	µm	
2	2 Points	2853.11	µm	
3	2 Points	2860.21	µm	
4	2 Points	2848.83	µm	
5	2 Points	2861.78	µm	
6	2 Points	2853.21	µm	
7	2 Points	2853.6	µm	
8	2 Points	2848.85	µm	
9	2 Points	2853.47	µm	
10	2 Points	2851.58	µm	
	Average (mean)	2854.82		
	Standard Deviation (σ)	5.21		
	% Relative Standard Deviation (RSD)	0.18		
11	2 Points	2838.28	µm	
12	2 Points	2840.39	µm	
13	2 Points	2840.09	µm	
14	2 Points	2846.42	µm	
15	2 Points	2838.31	µm	
16	2 Points	2829.47	µm	
17	2 Points	2846.45	µm	
18	2 Points	2846.44	µm	
19	2 Points	2846.45	µm	
20	2 Points	2844.48	µm	
	Average (mean)	2841.68		
	Standard Deviation (σ)	5.52		
	% Relative Standard Deviation (RSD)	0.19		
21	2 Points	2833.8	µm	
22	2 Points	2819.06	µm	
23	2 Points	2844.45	µm	
24	2 Points	2823.16	µm	
25	2 Points	2833.89	µm	
26	2 Points	2827.56	µm	
27	2 Points	2821.02	µm	
28	2 Points	2812.81	µm	
29	2 Points	2835.95	µm	
30	2 Points	2829.5	µm	
	Average (mean)	2828.12		
	Standard Deviation (σ)	9.35		
	% Relative Standard Deviation (RSD)	0.33		
31	2 Points	2833.8	µm	
32	2 Points	2827.39	µm	
33	2 Points	2823.14	µm	
34	2 Points	2820.96	µm	
35	2 Points	2825.29	µm	
36	2 Points	2829.42	µm	
37	2 Points	2831.68	µm	
38	2 Points	2836.11	µm	
39	2 Points	2831.57	µm	
40	2 Points	2835.82	µm	
	Average (mean)	2829.52		
	Standard Deviation (σ)	5.24		
	% Relative Standard Deviation (RSD)	0.19		
41	2 Points	2824.5	µm	
42	2 Points	2803.09	µm	
43	2 Points	2811.45	µm	
44	2 Points	2800.97	µm	
45	2 Points	2824.13	µm	
46	2 Points	2791.78	µm	
47	2 Points	2823.91	µm	
48	2 Points	2812.07	µm	
49	2 Points	2828.56	µm	
50	2 Points	2818.29	µm	
	Average (mean)	2813.88		
	Standard Deviation (σ)	12.18		
	% Relative Standard Deviation (RSD)	0.43		

After treatment

Title	Measurement Result			
Date saved	5/18/2017	3:23 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	2831.48	µm	
2	2 Points	2831.02	µm	
3	2 Points	2842.42	µm	
4	2 Points	2842.42	µm	
5	2 Points	2837.95	µm	
6	2 Points	2829.35	µm	
7	2 Points	2844.91	µm	
8	2 Points	2830.58	µm	
9	2 Points	2850.45	µm	
10	2 Points	2844.09	µm	
	Average (mean)	2838.47		-1.07
	Standard Deviation (σ)	7.44		
	% Relative Standard Deviation (RSD)	0.26		
11	2 Points	2807.73	µm	
12	2 Points	2800.74	µm	
13	2 Points	2813.26	µm	
14	2 Points	2806.81	µm	
15	2 Points	2815.49	µm	
16	2 Points	2809.32	µm	
17	2 Points	2810.87	µm	
18	2 Points	2811.75	µm	
19	2 Points	2805.21	µm	
20	2 Points	2812.18	µm	
	Average (mean)	2809.34		1.15
	Standard Deviation (σ)	4.34		
	% Relative Standard Deviation (RSD)	0.15		
21	2 Points	2811.38	µm	
22	2 Points	2783.69	µm	
23	2 Points	2803.53	µm	
24	2 Points	2789.91	µm	
25	2 Points	2799.3	µm	
26	2 Points	2788.16	µm	
27	2 Points	2796.76	µm	
28	2 Points	2794.64	µm	
29	2 Points	2793.09	µm	
30	2 Points	2797.11	µm	
	Average (mean)	2795.76		0.94
	Standard Deviation (σ)	7.93		
	% Relative Standard Deviation (RSD)	0.28		
31	2 Points	2772.64	µm	
32	2 Points	2768.03	µm	
33	2 Points	2751.73	µm	
34	2 Points	2772.12	µm	
35	2 Points	2759.91	µm	
36	2 Points	2765.93	µm	
37	2 Points	2754.77	µm	
38	2 Points	2766.02	µm	
39	2 Points	2757.11	µm	
40	2 Points	2759.05	µm	
	Average (mean)	2762.73		-0.53
	Standard Deviation (σ)	7.25		
	% Relative Standard Deviation (RSD)	0.26		
41	2 Points	2791.17	µm	
42	2 Points	2788.54	µm	
43	2 Points	2786.22	µm	
44	2 Points	2786.76	µm	
45	2 Points	2786.7	µm	
46	2 Points	2786.04	µm	
47	2 Points	2790.66	µm	
48	2 Points	2781.67	µm	
49	2 Points	2788.46	µm	
50	2 Points	2794.97	µm	
	Average (mean)	2788.12		-0.30
	Standard Deviation (σ)	3.60		
	% Relative Standard Deviation (RSD)	0.13		
	Average % change			0.04

Spruce root non-basketry 1, cross section (control)
- Width before, during and after treatment

Before treatment

	Title	Measurement Result		
	Date saved	5/10/2017	1:52 PM	
	No.	Measure	Result	Unit
Spot # 1	1	2 Points	1044.77	µm
	2	2 Points	1044.67	µm
	3	2 Points	1049.51	µm
	4	2 Points	1030.26	µm
	5	2 Points	1048.32	µm
	6	2 Points	1035.95	µm
	7	2 Points	1038.83	µm
	8	2 Points	1051.14	µm
	9	2 Points	1045.45	µm
	10	2 Points	1042.65	µm
		Average (mean)	1043.16	
		Standard Deviation (σ)	6.48	
		% Relative Standard Deviation (%RSD)	0.62	
Spot # 2	11	2 Points	1201.24	µm
	12	2 Points	1205.53	µm
	13	2 Points	1198.38	µm
	14	2 Points	1204.16	µm
	15	2 Points	1190	µm
	16	2 Points	1203.21	µm
	17	2 Points	1195.51	µm
	18	2 Points	1193.96	µm
	19	2 Points	1191.28	µm
	20	2 Points	1193.77	µm
		Average (mean)	1197.70	
		Standard Deviation (σ)	5.59	
		% Relative Standard Deviation (%RSD)	0.47	
Spot # 3	21	2 Points	1224.64	µm
	22	2 Points	1227.8	µm
	23	2 Points	1226.61	µm
	24	2 Points	1225.03	µm
	25	2 Points	1225.57	µm
	26	2 Points	1223.85	µm
	27	2 Points	1225.03	µm
	28	2 Points	1234.59	µm
	29	2 Points	1224.64	µm
	30	2 Points	1227.39	µm
		Average (mean)	1226.52	
		Standard Deviation (σ)	3.11	
		% Relative Standard Deviation (%RSD)	0.25	

During treatment

Title	Measurement Result		
Date saved	5/16/2017	2:36 PM	
No.	Measure	Result	Unit
1	2 Points	1070.53	µm
2	2 Points	1071.43	µm
3	2 Points	1070.53	µm
4	2 Points	1069.52	µm
5	2 Points	1068.51	µm
6	2 Points	1072.45	µm
7	2 Points	1068.72	µm
8	2 Points	1067.7	µm
9	2 Points	1074.26	µm
10	2 Points	1072.34	µm
	Average (mean)	1070.60	
	Standard Deviation (σ)	2.06	
	% Relative Standard Deviation (%RSD)	0.19	
11	2 Points	1234.04	µm
12	2 Points	1234.79	µm
13	2 Points	1233.15	µm
14	2 Points	1234.79	µm
15	2 Points	1230.63	µm
16	2 Points	1240.27	µm
17	2 Points	1237.02	µm
18	2 Points	1237.02	µm
19	2 Points	1240.72	µm
20	2 Points	1239.1	µm
	Average (mean)	1236.15	
	Standard Deviation (σ)	3.26	
	% Relative Standard Deviation (%RSD)	0.26	
21	2 Points	1224.34	µm
22	2 Points	1227.1	µm
23	2 Points	1228.7	µm
24	2 Points	1234.23	µm
25	2 Points	1233.81	µm
26	2 Points	1233.43	µm
27	2 Points	1227.53	µm
28	2 Points	1223.96	µm
29	2 Points	1228.7	µm
30	2 Points	1228.7	µm
	Average (mean)	1229.05	
	Standard Deviation (σ)	3.70	
	% Relative Standard Deviation (%RSD)	0.30	

After treatment

Title	Measurement Result			
Date saved	5/18/2017	2:27 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	1053.83	µm	
2	2 Points	1061.22	µm	
3	2 Points	1062.26	µm	
4	2 Points	1060.51	µm	
5	2 Points	1063	µm	
6	2 Points	1058.4	µm	
7	2 Points	1059.15	µm	
8	2 Points	1057.52	µm	
9	2 Points	1063.15	µm	
10	2 Points	1060.18	µm	
	Average (mean)	1059.92		1.61
	Standard Deviation (σ)	2.85		
	% Relative Standard Deviation (%RSD)	0.27		
11	2 Points	1202.57	µm	
12	2 Points	1205.68	µm	
13	2 Points	1205.68	µm	
14	2 Points	1207.43	µm	
15	2 Points	1200.85	µm	
16	2 Points	1208.85	µm	
17	2 Points	1208.23	µm	
18	2 Points	1214.13	µm	
19	2 Points	1195.92	µm	
20	2 Points	1207.49	µm	
	Average (mean)	1205.68		0.67
	Standard Deviation (σ)	4.97		
	% Relative Standard Deviation (%RSD)	0.41		
21	2 Points	1241.12	µm	
22	2 Points	1243.02	µm	
23	2 Points	1238.36	µm	
24	2 Points	1241.17	µm	
25	2 Points	1245.87	µm	
26	2 Points	1247.76	µm	
27	2 Points	1246.8	µm	
28	2 Points	1248.73	µm	
29	2 Points	1243.02	µm	
30	2 Points	1240.25	µm	
	Average (mean)	1243.61		1.39
	Standard Deviation (σ)	3.50		
	% Relative Standard Deviation (%RSD)	0.28		
	Average % Change			1.22

Spruce root non-basketry 2, cross section (water) - Width before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	5/10/2017	2:08 PM	
No.	Measure	Result	Unit
1	2 Points	1074.61	µm
2	2 Points	1080.6	µm
3	2 Points	1064.69	µm
4	2 Points	1060.55	µm
5	2 Points	1069.53	µm
6	2 Points	1079.65	µm
7	2 Points	1067.23	µm
8	2 Points	1070.3	µm
9	2 Points	1070.3	µm
10	2 Points	1067.91	µm
	Average (mean)	1070.54	
	Standard Deviation (σ)	6.27	
	% Relative Standard Deviation (%RSD)	0.59	
11	2 Points	1287.16	µm
12	2 Points	1284.52	µm
13	2 Points	1280.09	µm
14	2 Points	1287.76	µm
15	2 Points	1274.57	µm
16	2 Points	1283.88	µm
17	2 Points	1287.99	µm
18	2 Points	1283.58	µm
19	2 Points	1286.8	µm
20	2 Points	1279.5	µm
	Average (mean)	1283.59	
	Standard Deviation (σ)	4.36	
	% Relative Standard Deviation (%RSD)	0.34	
21	2 Points	1236.93	µm
22	2 Points	1237.8	µm
23	2 Points	1246.83	µm
24	2 Points	1239.84	µm
25	2 Points	1234.31	µm
26	2 Points	1243.91	µm
27	2 Points	1241.02	µm
28	2 Points	1243.33	µm
29	2 Points	1245.68	µm
30	2 Points	1234.31	µm
	Average (mean)	1240.40	
	Standard Deviation (σ)	4.52	
	% Relative Standard Deviation (%RSD)	0.36	

During treatment

Title	Measurement Result		
Date saved	5/16/2017	3:43 PM	
No.	Measure	Result	Unit
1	2 Points	1132.88	µm
2	2 Points	1135.99	µm
3	2 Points	1134.43	µm
4	2 Points	1129.88	µm
5	2 Points	1134.23	µm
6	2 Points	1140.24	µm
7	2 Points	1140.33	µm
8	2 Points	1140.43	µm
9	2 Points	1140.43	µm
10	2 Points	1137.33	µm
	Average (mean)	1136.62	
	Standard Deviation (σ)	3.75	
	% Relative Standard Deviation (%RSD)	0.33	
11	2 Points	1300.6	µm
12	2 Points	1299.17	µm
13	2 Points	1298.46	µm
14	2 Points	1300.46	µm
15	2 Points	1301.88	µm
16	2 Points	1303.17	µm
17	2 Points	1303.88	µm
18	2 Points	1304.6	µm
19	2 Points	1301.88	µm
20	2 Points	1301.88	µm
	Average (mean)	1301.60	
	Standard Deviation (σ)	1.97	
	% Relative Standard Deviation (%RSD)	0.15	
21	2 Points	1231.63	µm
22	2 Points	1231.22	µm
23	2 Points	1225.38	µm
24	2 Points	1228.29	µm
25	2 Points	1225.38	µm
26	2 Points	1228.29	µm
27	2 Points	1230.79	µm
28	2 Points	1224.13	µm
29	2 Points	1237.04	µm
30	2 Points	1234.12	µm
	Average (mean)	1229.63	
	Standard Deviation (σ)	4.12	
	% Relative Standard Deviation (%RSD)	0.34	

After treatment

Title	Measurement Result			
Date saved	5/18/2017	3:02 PM		
No.	Measure	Result	Unit	% change
1	2 Points	1079.96	µm	
2	2 Points	1071.15	µm	
3	2 Points	1073.38	µm	
4	2 Points	1070.96	µm	
5	2 Points	1071.16	µm	
6	2 Points	1073.45	µm	
7	2 Points	1065.16	µm	
8	2 Points	1070.78	µm	
9	2 Points	1065.16	µm	
10	2 Points	1066.38	µm	
	Average (mean)	1070.75		0.02
	Standard Deviation (σ)	4.48		
	% Relative Standard Deviation (%RSD)	0.42		
11	2 Points	1301.91	µm	
12	2 Points	1306.61	µm	
13	2 Points	1302.63	µm	
14	2 Points	1301.26	µm	
15	2 Points	1306.67	µm	
16	2 Points	1302.63	µm	
17	2 Points	1311.36	µm	
18	2 Points	1305.3	µm	
19	2 Points	1301.91	µm	
20	2 Points	1299.2	µm	
	Average (mean)	1303.95		1.59
	Standard Deviation (σ)	3.54		
	% Relative Standard Deviation (%RSD)	0.27		
21	2 Points	1232.42	µm	
22	2 Points	1236.52	µm	
23	2 Points	1244.74	µm	
24	2 Points	1243.23	µm	
25	2 Points	1246.37	µm	
26	2 Points	1235.57	µm	
27	2 Points	1244.32	µm	
28	2 Points	1248.97	µm	
29	2 Points	1245.43	µm	
30	2 Points	1248.04	µm	
	Average (mean)	1242.56		0.17
	Standard Deviation (σ)	5.68		
	% Relative Standard Deviation (%RSD)	0.46		
	Average % change			0.59

Spruce root non-basketry 3, cross section (ethanol)
- Width before, during and after treatment

Before treatment

Title	Measurement Result		
Date saved	5/10/2017	2:26 PM	
No.	Measure	Result	Unit
1	2 Points	726.49	µm
2	2 Points	728.45	µm
3	2 Points	730.08	µm
4	2 Points	730.91	µm
5	2 Points	726.17	µm
6	2 Points	727.3	µm
7	2 Points	729.78	µm
8	2 Points	725.88	µm
9	2 Points	728.12	µm
10	2 Points	726.17	µm
	Average (mean)	727.94	
	Standard Deviation (σ)	1.83	
	% Relative Standard Deviation (%RSD)	0.25	
11	2 Points	800.61	µm
12	2 Points	800.27	µm
13	2 Points	802.7	µm
14	2 Points	811.78	µm
15	2 Points	808.67	µm
16	2 Points	805.85	µm
17	2 Points	806.89	µm
18	2 Points	813.87	µm
19	2 Points	814.22	µm
20	2 Points	807.94	µm
	Average (mean)	807.28	
	Standard Deviation (σ)	5.07	
	% Relative Standard Deviation (%RSD)	0.63	
21	2 Points	754.32	µm
22	2 Points	754.08	µm
23	2 Points	760.18	µm
24	2 Points	764.65	µm
25	2 Points	765.76	µm
26	2 Points	761.02	µm
27	2 Points	765.51	µm
28	2 Points	762.71	µm
29	2 Points	763.81	µm
30	2 Points	764.65	µm
	Average (mean)	761.67	
	Standard Deviation (σ)	4.34	
	% Relative Standard Deviation (%RSD)	0.57	

During treatment

Title	Measurement Result		
Date saved	5/16/2017	4:20 PM	
No.	Measure	Result	Unit
1	2 Points	761.35	µm
2	2 Points	769.25	µm
3	2 Points	770.03	µm
4	2 Points	775.18	µm
5	2 Points	763.74	µm
6	2 Points	776.35	µm
7	2 Points	774.76	µm
8	2 Points	775.18	µm
9	2 Points	770.82	µm
10	2 Points	769.64	µm
	Average (mean)	770.63	
	Standard Deviation (σ)	5.03	
	% Relative Standard Deviation (%RSD)	0.65	
11	2 Points	955.59	µm
12	2 Points	961.73	µm
13	2 Points	966.78	µm
14	2 Points	963.85	µm
15	2 Points	971.45	µm
16	2 Points	969.11	µm
17	2 Points	959.62	µm
18	2 Points	962.35	µm
19	2 Points	973.34	µm
20	2 Points	965.22	µm
	Average (mean)	964.90	
	Standard Deviation (σ)	5.45	
	% Relative Standard Deviation (%RSD)	0.57	
21	2 Points	968.63	µm
22	2 Points	963.89	µm
23	2 Points	965.62	µm
24	2 Points	964.75	µm
25	2 Points	975.55	µm
26	2 Points	972.75	µm
27	2 Points	958.75	µm
28	2 Points	972.75	µm
29	2 Points	981.79	µm
30	2 Points	977.91	µm
	Average (mean)	970.24	
	Standard Deviation (σ)	7.14	
	% Relative Standard Deviation (%RSD)	0.74	

After treatment

Title	Measurement Result			
Date saved	5/18/2017	3:29 PM		
No.	Measure	Result	Unit	% change
1	2 Points	731.66	µm	
2	2 Points	739.41	µm	
3	2 Points	742.22	µm	
4	2 Points	741.15	µm	
5	2 Points	737.29	µm	
6	2 Points	737.69	µm	
7	2 Points	733.81	µm	
8	2 Points	743.09	µm	
9	2 Points	743.09	µm	
10	2 Points	737.29	µm	
	Average (mean)	738.67		1.47
	Standard Deviation (σ)	3.89		
	% Relative Standard Deviation (%RSD)	0.53		
11	2 Points	942.88	µm	
12	2 Points	941.94	µm	
13	2 Points	946.76	µm	
14	2 Points	952.25	µm	
15	2 Points	943.53	µm	
16	2 Points	940.78	µm	
17	2 Points	947.72	µm	
18	2 Points	951.92	µm	
19	2 Points	951.59	µm	
20	2 Points	944.2	µm	
	Average (mean)	946.36		17.23
	Standard Deviation (σ)	4.35		
	% Relative Standard Deviation (%RSD)	0.46		
21	2 Points	938.91	µm	
22	2 Points	940.57	µm	
23	2 Points	944.55	µm	
24	2 Points	947.07	µm	
25	2 Points	945.81	µm	
26	2 Points	947.8	µm	
27	2 Points	945.29	µm	
28	2 Points	946.54	µm	
29	2 Points	947.07	µm	
30	2 Points	949.06	µm	
	Average (mean)	945.27		24.10
	Standard Deviation (σ)	3.20		
	% Relative Standard Deviation (%RSD)	0.34		
	Average % change			14.27

Willow - Basketry Sample 1 (H_20) - Measurements before, during and after humidification

Before treatment

Area on sample	Title	Measurement Result		
	Date saved	4/14/2017	1:01 PM	
	No.	**Measure**	**Result**	**Unit**
	1	2 Points	1840.11	µm
	2	2 Points	1836.84	µm
	3	2 Points	1863.68	µm
	4	2 Points	1839.74	µm
Spot # 1	5	2 Points	1825.98	µm
		Average (mean)	1841.27	
		Standard Deviation (σ)	13.78	
		% Relative Standard Deviation (RSD)	0.75	
	6	2 Points	2876.76	µm
	7	2 Points	2876.76	µm
	8	2 Points	2868.55	µm
	9	2 Points	2868.55	µm
Spot # 2	10	2 Points	2876.76	µm
		Average (mean)	2873.48	
		Standard Deviation (σ)	4.50	
		% Relative Standard Deviation (RSD)	0.16	
	11	2 Points	1885.06	µm
	12	2 Points	1876.58	µm
	13	2 Points	1893.99	µm
	14	2 Points	1885.06	µm
Spot # 3	15	2 Points	1867.59	µm
		Average (mean)	1881.66	
		Standard Deviation (σ)	9.99	
		% Relative Standard Deviation (RSD)	0.53	
	16	2 Points	1789.48	µm
	17	2 Points	1789.48	µm
	18	2 Points	1798.15	µm
	19	2 Points	1765.83	µm
Spot # 4	20	2 Points	1781.18	µm
		Average	1784.82	
		Standard Deviation (σ)	12.20	
		% Relative Standard Deviation (RSD)	0.68	
	21	2 Points	2174.19	µm
	22	2 Points	2175.15	µm
	23	2 Points	2172.37	µm
	24	2 Points	2154.61	µm
Spot # 5	25	2 Points	2145.83	µm
		Average	2164.43	
		Standard Deviation (σ)	13.38	
		% Relative Standard Deviation (RSD)	0.62	

During humidification

Title	Measurement Result		
Date saved	4/28/2017	11:00 AM	
No.	**Measure**	**Result**	**Unit**
1	2 Points	1850.87	µm
2	2 Points	1840.04	µm
3	2 Points	1843.55	µm
4	2 Points	1852.58	µm
5	2 Points	1854.2	µm
	Average (mean)	1848.25	
	Standard Deviation (σ)	6.13	
	% Relative Standard Deviation (RSD)	0.33	
6	2 Points	2961.13	µm
7	2 Points	2961.31	µm
8	2 Points	2948.03	µm
9	2 Points	2954.37	µm
10	2 Points	2948.23	µm
	Average (mean)	2954.61	
	Standard Deviation (σ)	6.55	
	% Relative Standard Deviation (RSD)	0.22	
11	2 Points	1890.64	µm
12	2 Points	1892.08	µm
13	2 Points	1891.36	µm
14	2 Points	1889.46	µm
15	2 Points	1891.4	µm
	Average (mean)	1890.99	
	Standard Deviation (σ)	0.99	
	% Relative Standard Deviation (RSD)	0.05	
16	2 Points	1719.34	µm
17	2 Points	1729.75	µm
18	2 Points	1726.43	µm
19	2 Points	1717.08	µm
20	2 Points	1731.35	µm
	Average (mean)	1724.79	
	Standard Deviation (σ)	6.31	
	% Relative Standard Deviation (RSD)	0.37	
21	2 Points	2149.45	µm
22	2 Points	2152.76	µm
23	2 Points	2142.53	µm
24	2 Points	2152.04	µm
25	2 Points	2149.51	µm
	Average (mean)	2149.26	
	Standard Deviation (σ)	4.04	
	% Relative Standard Deviation (RSD)	0.19	

After recovery

Title	Measurement Result			
Date saved	5/1/2017	11:06 AM		
No.	**Measure**	**Result**	**Unit**	**% Change**
1	2 Points	1845.97	µm	
2	2 Points	1838.68	µm	
3	2 Points	1829.03	µm	
4	2 Points	1835.26	µm	
5	2 Points	1838.49	µm	
	Average (mean)	1837.49		-0.206
	Standard Deviation (σ)	6.14		
	% Relative Standard Deviation (RSD)	0.33		
6	2 Points	2899.43	µm	
7	2 Points	2905.84	µm	
8	2 Points	2893.12	µm	
9	2 Points	2916.5	µm	
10	2 Points	2900.16	µm	
	Average (mean)	2903.01		1.028
	Standard Deviation (σ)	8.79		
	% Relative Standard Deviation (RSD)	0.30		
11	2 Points	1879.12	µm	
12	2 Points	1870.42	µm	
13	2 Points	1877.46	µm	
14	2 Points	1881.5	µm	
15	2 Points	1879.93	µm	
	Average (mean)	1877.69		-0.211
	Standard Deviation (σ)	4.32		
	% Relative Standard Deviation (RSD)	0.23		
16	2 Points	1852.06	µm	
17	2 Points	1844.96	µm	
18	2 Points	1852.89	µm	
19	2 Points	1841.56	µm	
20	2 Points	1844.2	µm	
	Average (mean)	1847.13		3.491
	Standard Deviation (σ)	5.04		
	% Relative Standard Deviation (RSD)	0.27		
21	2 Points	2144	µm	
22	2 Points	2146.86	µm	
23	2 Points	2133.75	µm	
24	2 Points	2132.52	µm	
25	2 Points	2128.76	µm	
	Average (mean)	2137.18		-1.259
	Standard Deviation (σ)	7.82		
	% Relative Standard Deviation (RSD)	0.37		
	Average % change			0.569

Willow - Basketry Sample 2 (ethanol) - Measurements before, during and after humidification

Before treatment

Title	Measurement Result		
Date saved	4/14/2017	1:21 PM	
No.	Measure	Result	Unit
1	2 Points	1681.09	ตm
2	2 Points	1684.85	ตm
3	2 Points	1671.58	ตm
4	2 Points	1691.81	ตm
5	2 Points	1673.45	ตm
	Average (mean)	1680.56	
	Standard Deviation (σ)	8.31	
	% Relative Standard Deviation (RSD)	0.49	
6	2 Points	1945.32	ตm
7	2 Points	1957.17	ตm
8	2 Points	1945.23	ตm
9	2 Points	1944.2	ตm
10	2 Points	1922.24	ตm
	Average (mean)	1942.83	
	Standard Deviation (σ)	12.68	
	% Relative Standard Deviation (RSD)	0.65	
11	2 Points	2994.8	ตm
12	2 Points	2976.66	ตm
13	2 Points	3004.89	ตm
14	2 Points	2985.51	ตm
15	2 Points	2999.28	ตm
	Average (mean)	2992.23	
	Standard Deviation (σ)	11.23	
	% Relative Standard Deviation (RSD)	0.38	
16	2 Points	1790.53	ตm
17	2 Points	1792.78	ตm
18	2 Points	1791.07	ตm
19	2 Points	1797.08	ตm
20	2 Points	1788.14	ตm
	Average (mean)	1791.92	
	Standard Deviation (σ)	3.33	
	% Relative Standard Deviation (RSD)	0.19	
21	2 Points	2205.33	ตm
22	2 Points	2195.78	ตm
23	2 Points	2211.46	ตm
24	2 Points	2191.91	ตm
25	2 Points	2185.5	ตm
	Average (mean)	2198.00	
	Standard Deviation (σ)	10.41	
	% Relative Standard Deviation (RSD)	0.47	

During conditioning

Title	Measurement Result		
Date saved	4/28/2017	11:35 AM	
No.	Measure	Result	Unit
1	2 Points	1876.54	ตm
2	2 Points	1885.72	ตm
3	2 Points	1896.72	ตm
4	2 Points	1892.08	ตm
5	2 Points	1893.02	ตm
	Average (mean)	1888.82	
	Standard Deviation (σ)	7.92	
	% Relative Standard Deviation (RSD)	0.42	
6	2 Points	1936.73	ตm
7	2 Points	1940.34	ตm
8	2 Points	1931.4	ตm
9	2 Points	1946.42	ตm
10	2 Points	1921.52	ตm
	Average (mean)	1935.28	
	Standard Deviation (σ)	9.44	
	% Relative Standard Deviation (RSD)	0.49	
11	2 Points	3037.09	ตm
12	2 Points	3034.94	ตm
13	2 Points	3042.31	ตm
14	2 Points	3040.85	ตm
15	2 Points	3032.86	ตm
	Average (mean)	3037.61	
	Standard Deviation (σ)	3.95	
	% Relative Standard Deviation (RSD)	0.13	
16	2 Points	1774.11	ตm
17	2 Points	1761.92	ตm
18	2 Points	1790.96	ตm
19	2 Points	1789.57	ตm
20	2 Points	1788.6	ตm
	Average (mean)	1781.03	
	Standard Deviation (σ)	12.67	
	% Relative Standard Deviation (RSD)	0.71	
21	2 Points	2209.55	ตm
22	2 Points	2194.45	ตm
23	2 Points	2203.46	ตm
24	2 Points	2202.79	ตm
25	2 Points	2209.27	ตm
	Average (mean)	2203.90	
	Standard Deviation (σ)	6.15	
	% Relative Standard Deviation (RSD)	0.28	

After recovery

Title	Measurement Result			
Date saved	5/1/2017	11:28 AM		
No.	Measure	Result	Unit	% Change
1	2 Points	1764.9	ตm	
2	2 Points	1769.33	ตm	
3	2 Points	1780.75	ตm	
4	2 Points	1773.12	ตm	
5	2 Points	1767.41	ตm	
	Average (mean)	1771.10		5.388
	Standard Deviation (σ)	6.17		
	% Relative Standard Deviation (RSD)	0.35		
6	2 Points	1959.81	ตm	
7	2 Points	1970.84	ตm	
8	2 Points	1960.62	ตm	
9	2 Points	1974.78	ตm	
10	2 Points	1967.41	ตm	
	Average (mean)	1966.69		1.228
	Standard Deviation (σ)	6.47		
	% Relative Standard Deviation (RSD)	0.33		
11	2 Points	3060.58	ตm	
12	2 Points	3060.84	ตm	
13	2 Points	3057.98	ตm	
14	2 Points	3054.48	ตm	
15	2 Points	3058.57	ตm	
	Average (mean)	3058.49		2.214
	Standard Deviation (σ)	2.56		
	% Relative Standard Deviation (RSD)	0.08		
16	2 Points	1777.04	ตm	
17	2 Points	1779.79	ตm	
18	2 Points	1781.65	ตm	
19	2 Points	1774.98	ตm	
20	2 Points	1779.8	ตm	
	Average (mean)	1778.65		-0.740
	Standard Deviation (σ)	2.63		
	% Relative Standard Deviation (RSD)	0.15		
21	2 Points	2262.92	ตm	
22	2 Points	2265.76	ตm	
23	2 Points	2265.63	ตm	
24	2 Points	2266.92	ตm	
25	2 Points	2268.35	ตm	
	Average (mean)	2265.92		3.090
	Standard Deviation (σ)	2.00		
	% Relative Standard Deviation (RSD)	0.09		
	Average % change			2.236

Willow - Basketry Sample 3 (70:30 water:ethanol) - Measurements before, during and after humidification

Before treatment

Title	Measurement Result		
Date saved	4/14/2017	1:41 PM	
No.	Measure	Result	Unit
1	2 Points	2866.66	μm
2	2 Points	2868.01	μm
3	2 Points	2862.68	μm
4	2 Points	2845.03	μm
5	2 Points	2849.43	μm
	Average (mean)	2858.36	
	Standard Deviation (σ)	10.47	
	% Relative Standard Deviation (RSD)	0.37	
6	2 Points	2419.05	μm
7	2 Points	2412.47	μm
8	2 Points	2418.84	μm
9	2 Points	2424.78	μm
10	2 Points	2412.16	μm
	Average (mean)	2417.46	
	Standard Deviation (σ)	5.27	
	% Relative Standard Deviation (RSD)	0.22	
11	2 Points	1768.11	μm
12	2 Points	1768	μm
13	2 Points	1768.07	μm
14	2 Points	1768.02	μm
15	2 Points	1768.33	μm
	Average (mean)	1768.11	
	Standard Deviation (σ)	0.13	
	% Relative Standard Deviation (RSD)	0.01	
16	2 Points	1734.33	μm
17	2 Points	1733.16	μm
18	2 Points	1743.39	μm
19	2 Points	1738.79	μm
20	2 Points	1746.5	μm
	Average (mean)	1739.23	
	Standard Deviation (σ)	5.73	
	% Relative Standard Deviation (RSD)	0.33	
21	2 Points	1777	μm
22	2 Points	1762.15	μm
23	2 Points	1774.59	μm
24	2 Points	1774.59	μm
25	2 Points	1782.99	μm
	Average (mean)	1774.26	
	Standard Deviation (σ)	7.59	
	% Relative Standard Deviation (RSD)	0.43	

During treatment

Title	Measurement Result		
Date saved	4/28/2017	12:31 PM	
No.	Measure	Result	Unit
1	2 Points	2834.62	μm
2	2 Points	2810.39	μm
3	2 Points	2821.17	μm
4	2 Points	2814.87	μm
5	2 Points	2815.99	μm
	Average (mean)	2819.41	
	Standard Deviation (σ)	9.33	
	% Relative Standard Deviation (RSD)	0.33	
6	2 Points	2358.5	μm
7	2 Points	2358.47	μm
8	2 Points	2364.03	μm
9	2 Points	2351.7	μm
10	2 Points	2359.38	μm
	Average (mean)	2358.42	
	Standard Deviation (σ)	4.40	
	% Relative Standard Deviation (RSD)	0.19	
11	2 Points	1765.93	μm
12	2 Points	1771.64	μm
13	2 Points	1777.03	μm
14	2 Points	1759.68	μm
15	2 Points	1776.67	μm
	Average (mean)	1770.19	
	Standard Deviation (σ)	7.41	
	% Relative Standard Deviation (RSD)	0.42	
16	2 Points	1736.73	μm
17	2 Points	1727.91	μm
18	2 Points	1720.19	μm
19	2 Points	1717.44	μm
20	2 Points	1717.8	μm
	Average (mean)	1724.01	
	Standard Deviation (σ)	8.27	
	% Relative Standard Deviation (RSD)	0.48	
21	2 Points	1794.93	μm
22	2 Points	1793.66	μm
23	2 Points	1804.73	μm
24	2 Points	1797.07	μm
25	2 Points	1808.85	μm
	Average (mean)	1799.85	
	Standard Deviation (σ)	6.62	
	% Relative Standard Deviation (RSD)	0.37	

After treatment

Title	Measurement Result			
Date saved	5/1/2017	11:48 AM		
No.	Measure	Result	Unit	% Change
1	2 Points	2935.68	μm	
2	2 Points	2934.73	μm	
3	2 Points	2920.62	μm	
4	2 Points	2918.17	μm	
5	2 Points	2942.33	μm	
	Average (mean)	2930.31		2.517
	Standard Deviation (σ)	10.42		
	% Relative Standard Deviation (RSD)	0.36		
6	2 Points	2449.89	μm	
7	2 Points	2445.47	μm	
8	2 Points	2452	μm	
9	2 Points	2446.23	μm	
10	2 Points	2451.95	μm	
	Average (mean)	2449.11		1.309
	Standard Deviation (σ)	3.11		
	% Relative Standard Deviation (RSD)	0.13		
11	2 Points	1706.85	μm	
12	2 Points	1701.54	μm	
13	2 Points	1711.22	μm	
14	2 Points	1701.81	μm	
15	2 Points	1707.78	μm	
	Average (mean)	1705.84		-3.522
	Standard Deviation (σ)	4.14		
	% Relative Standard Deviation (RSD)	0.24		
16	2 Points	1729.24	μm	
17	2 Points	1730.14	μm	
18	2 Points	1731.08	μm	
19	2 Points	1728.04	μm	
20	2 Points	1723.63	μm	
	Average (mean)	1728.43		-0.621
	Standard Deviation (σ)	2.91		
	% Relative Standard Deviation (RSD)	0.17		
21	2 Points	1775.67	μm	
22	2 Points	1777.3	μm	
23	2 Points	1780.25	μm	
24	2 Points	1778.06	μm	
25	2 Points	1793.84	μm	
	Average (mean)	1781.02		0.381
	Standard Deviation (σ)	7.35		
	% Relative Standard Deviation (RSD)	0.41		
	Average % change			0.013

Willow - Basketry Sample 4 (50:50 water:ethanol) - Measurements before, during and after humidification

Before treatment

Title	Measurement Result		
Date saved	4/14/2017	2:01 PM	
No.	Measure	Result	Unit
1	2 Points	2756.31	µ
2	2 Points	2758.22	µ
3	2 Points	2749.34	µ
4	2 Points	2749.34	µ
5	2 Points	2757.44	µ
	Average (mean)	2754.13	
	Standard Deviation (σ)	4.43	
	% Relative Standard Deviation (RSD)	0.16	
6	2 Points	1947.31	µ
7	2 Points	1956.85	µ
8	2 Points	1940.98	µ
9	2 Points	1930.59	µ
10	2 Points	1930.59	µ
	Average (mean)	1941.26	
	Standard Deviation (σ)	11.26	
	% Relative Standard Deviation (RSD)	0.58	
11	2 Points	1967.59	µ
12	2 Points	1983.01	µ
13	2 Points	1978.83	µ
14	2 Points	1974.07	µ
15	2 Points	1979.21	µ
	Average (mean)	1976.54	
	Standard Deviation (σ)	5.93	
	% Relative Standard Deviation (RSD)	0.30	
16	2 Points	1565.2	µ
17	2 Points	1567.16	µ
18	2 Points	1562.22	µ
19	2 Points	1561.82	µ
20	2 Points	1558.26	µ
	Average (mean)	1562.93	
	Standard Deviation (σ)	3.41	
	% Relative Standard Deviation (RSD)	0.22	
21	2 Points	1629.45	µ
22	2 Points	1628.9	µ
23	2 Points	1631.38	µ
24	2 Points	1639.66	µ
25	2 Points	1631.38	µ
	Average (mean)	1632.15	
	Standard Deviation (σ)	4.34	
	% Relative Standard Deviation (RSD)	0.27	

During treatment

Title	Measurement Result		
Date saved	4/28/2017	12:58 PM	
No.	Measure	Result	Unit
1	2 Points	2692.44	µ
2	2 Points	2680.05	µ
3	2 Points	2689.06	µ
4	2 Points	2668.19	µ
5	2 Points	2667.67	µ
	Average (mean)	2679.48	
	Standard Deviation (σ)	11.48	
	% Relative Standard Deviation (RSD)	0.43	
6	2 Points	1977.33	µ
7	2 Points	1980.02	µ
8	2 Points	1969.96	µ
9	2 Points	1972.27	µ
10	2 Points	1973.96	µ
	Average (mean)	1974.71	
	Standard Deviation (σ)	4.00	
	% Relative Standard Deviation (RSD)	0.20	
11	2 Points	1936.85	µ
12	2 Points	1888.34	µ
13	2 Points	1918	µ
14	2 Points	1896.37	µ
15	2 Points	1904.05	µ
	Average (mean)	1908.72	
	Standard Deviation (σ)	19.15	
	% Relative Standard Deviation (RSD)	1.00	
16	2 Points	1566.12	µ
17	2 Points	1550.21	µ
18	2 Points	1532.56	µ
19	2 Points	1548.7	µ
20	2 Points	1551.62	µ
	Average (mean)	1549.84	
	Standard Deviation (σ)	11.92	
	% Relative Standard Deviation (RSD)	0.77	
21	2 Points	1641.22	µ
22	2 Points	1632.04	µ
23	2 Points	1644.59	µ
24	2 Points	1639.64	µ
25	2 Points	1637.48	µ
	Average (mean)	1638.99	
	Standard Deviation (σ)	4.67	
	% Relative Standard Deviation (RSD)	0.29	

After treatment

Title	Measurement Result			
Date saved	5/1/2017	12:12 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	2678.81	µ	
2	2 Points	2689.88	µ	
3	2 Points	2655.88	µ	
4	2 Points	2661.18	µ	
5	2 Points	2671.76	µ	
	Average (mean)	2671.50		-3.00
	Standard Deviation (σ)	13.62		
	% Relative Standard Deviation (RSD)	0.51		
6	2 Points	1948.86	µ	
7	2 Points	1954.98	µ	
8	2 Points	1946.53	µ	
9	2 Points	1947.28	µ	
10	2 Points	1952.61	µ	
	Average (mean)	1950.05		0.45
	Standard Deviation (σ)	3.62		
	% Relative Standard Deviation (RSD)	0.19		
11	2 Points	1883.33	µ	
12	2 Points	1885.9	µ	
13	2 Points	1870.93	µ	
14	2 Points	1899.93	µ	
15	2 Points	1885.71	µ	
	Average (mean)	1885.16		-4.62
	Standard Deviation (σ)	10.31		
	% Relative Standard Deviation (RSD)	0.55		
16	2 Points	1555.87	µ	
17	2 Points	1546.49	µ	
18	2 Points	1554.19	µ	
19	2 Points	1543.9	µ	
20	2 Points	1541.32	µ	
	Average (mean)	1548.35		-0.93
	Standard Deviation (σ)	6.39		
	% Relative Standard Deviation (RSD)	0.41		
21	2 Points	1631.2	µ	
22	2 Points	1634.05	µ	
23	2 Points	1614.51	µ	
24	2 Points	1630.81	µ	
25	2 Points	1621.76	µ	
	Average (mean)	1626.47		-0.35
	Standard Deviation (σ)	8.12		
	% Relative Standard Deviation (RSD)	0.50		
	Average % change			-1.69

Willow - Basketry Sample 5 (30:70 water:ethanol) - Measurements before, during and after humidification

Before treatment

Title	Measurement Result		
Date saved	4/14/2017	2:19 PM	
No.	Measure	Result	Unit
1	2 Points	2077.22	µm
2	2 Points	2074.13	µm
3	2 Points	2087.99	µm
4	2 Points	2067.85	µm
5	2 Points	2069.31	µm
	Average (mean)	2075.30	
	Standard Deviation (σ)	8.02	
	% Relative Standard Deviation (RSD)	0.39	
6	2 Points	2725.22	µm
7	2 Points	2735.04	µm
8	2 Points	2721.73	µm
9	2 Points	2733	µm
10	2 Points	2724.25	µm
	Average (mean)	2727.85	
	Standard Deviation (σ)	5.82	
	% Relative Standard Deviation (RSD)	0.21	
11	2 Points	1804.92	µm
12	2 Points	1823.03	µm
13	2 Points	1817.02	µm
14	2 Points	1817.82	µm
15	2 Points	1819.57	µm
	Average (mean)	1816.47	
	Standard Deviation (σ)	6.86	
	% Relative Standard Deviation (RSD)	0.38	
16	2 Points	1856.61	µm
17	2 Points	1844.47	µm
18	2 Points	1835.79	µm
19	2 Points	1851.32	µm
20	2 Points	1864.6	µm
	Average (mean)	1850.56	
	Standard Deviation (σ)	11.06	
	% Relative Standard Deviation (RSD)	0.60	
21	2 Points	1551.32	µm
22	2 Points	1543.23	µm
23	2 Points	1554.42	µm
24	2 Points	1562.55	µm
25	2 Points	1561.99	µm
	Average (mean)	1554.70	
	Standard Deviation (σ)	8.03	
	% Relative Standard Deviation (RSD)	0.52	

During treatment

Title	Measurement Result		
Date saved	4/28/2017	1:17 PM	
No.	Measure	Result	Unit
1	2 Points	2166.68	µm
2	2 Points	2143.28	µm
3	2 Points	2146.83	µm
4	2 Points	2152.28	µm
5	2 Points	2145.11	µm
	Average (mean)	2150.84	
	Standard Deviation (σ)	9.47	
	% Relative Standard Deviation (RSD)	0.44	
6	2 Points	2785.15	µm
7	2 Points	2785.04	µm
8	2 Points	2797.94	µm
9	2 Points	2796.56	µm
10	2 Points	2792.81	µm
	Average (mean)	2791.50	
	Standard Deviation (σ)	6.14	
	% Relative Standard Deviation (RSD)	0.22	
11	2 Points	1859.69	µm
12	2 Points	1849.15	µm
13	2 Points	1858.73	µm
14	2 Points	1853.74	µm
15	2 Points	1855.93	µm
	Average (mean)	1855.45	
	Standard Deviation (σ)	4.23	
	% Relative Standard Deviation (RSD)	0.23	
16	2 Points	1891.81	µm
17	2 Points	1883.67	µm
18	2 Points	1882.98	µm
19	2 Points	1896.25	µm
20	2 Points	1891.01	µm
	Average (mean)	1889.14	
	Standard Deviation (σ)	5.68	
	% Relative Standard Deviation (RSD)	0.30	
21	2 Points	1614.91	µm
22	2 Points	1607.52	µm
23	2 Points	1614.92	µm
24	2 Points	1633.02	µm
25	2 Points	1650.7	µm
	Average (mean)	1624.21	
	Standard Deviation (σ)	17.54	
	% Relative Standard Deviation (RSD)	1.08	

After treatment

Title	Measurement Result			
Date saved	5/1/2017	12:28 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	2130.27	µm	
2	2 Points	2135.73	µm	
3	2 Points	2119.56	µm	
4	2 Points	2142.39	µm	
5	2 Points	2135.1	µm	
	Average (mean)	2132.61		2.76
	Standard Deviation (σ)	8.48		
	% Relative Standard Deviation (RSD)	0.40		
6	2 Points	2796.84	µm	
7	2 Points	2810.05	µm	
8	2 Points	2775.31	µm	
9	2 Points	2774.19	µm	
10	2 Points	2814.05	µm	
	Average (mean)	2794.09		2.43
	Standard Deviation (σ)	18.77		
	% Relative Standard Deviation (RSD)	0.67		
11	2 Points	1947.2	µm	
12	2 Points	1940.73	µm	
13	2 Points	1950.81	µm	
14	2 Points	1956.68	µm	
15	2 Points	1947.49	µm	
	Average (mean)	1948.58		7.27
	Standard Deviation (σ)	5.82		
	% Relative Standard Deviation (RSD)	0.30		
16	2 Points	1926.49	µm	
17	2 Points	1915.41	µm	
18	2 Points	1934.73	µm	
19	2 Points	1924.32	µm	
20	2 Points	1922.25	µm	
	Average (mean)	1924.64		4.00
	Standard Deviation (σ)	7.00		
	% Relative Standard Deviation (RSD)	0.36		
21	2 Points	1534.92	µm	
22	2 Points	1541.65	µm	
23	2 Points	1513.11	µm	
24	2 Points	1508.74	µm	
25	2 Points	1560.99	µm	
	Average (mean)	1531.88		-1.47
	Standard Deviation (σ)	21.45		
	% Relative Standard Deviation (RSD)	1.40		
	Average % change			3.00

Willow - Basketry Sample 6 (control) - Measurements before, during and after humidification

Before treatment

Title	Measurement Result		
Date saved	4/14/2017	2:34 PM	
No.	Measure	Result	Unit
1	2 Points	2694.39	µ
2	2 Points	2705.82	µ
3	2 Points	2695.5	µ
4	2 Points	2695.84	µ
5	2 Points	2689.29	µ
	Average (mean)	2696.17	
	Standard Deviation (σ)	6.00	
	% Relative Standard Deviation (RSD)	0.22	
6	2 Points	1809.1	µ
7	2 Points	1820.91	µ
8	2 Points	1816.88	µ
9	2 Points	1805.88	µ
10	2 Points	1797.19	µ
	Average (mean)	1809.99	
	Standard Deviation (σ)	9.33	
	% Relative Standard Deviation (RSD)	0.52	
11	2 Points	1744.89	µm
12	2 Points	1732.33	µm
13	2 Points	1749.5	µm
14	2 Points	1732.61	µm
15	2 Points	1738.27	µm
	Average (mean)	1739.52	
	Standard Deviation (σ)	7.57	
	% Relative Standard Deviation (RSD)	0.44	
16	2 Points	1852.85	µ
17	2 Points	1846.55	µ
18	2 Points	1851.71	µ
19	2 Points	1847.3	µ
20	2 Points	1839.49	µ
	Average (mean)	1847.58	
	Standard Deviation (σ)	5.28	
	% Relative Standard Deviation (RSD)	0.29	
21	2 Points	1755.43	µ
22	2 Points	1749.89	µ
23	2 Points	1750.33	µ
24	2 Points	1742.33	µ
25	2 Points	1741.89	µ
	Average (mean)	1747.97	
	Standard Deviation (σ)	5.78	
	% Relative Standard Deviation (RSD)	0.33	

During treatment

Title	Measurement Result		
Date saved	4/28/2017	1:37 PM	
No.	Measure	Result	Unit
1	2 Points	2688.3	µ
2	2 Points	2683.42	µ
3	2 Points	2682.97	µ
4	2 Points	2684.51	µ
5	2 Points	2677.7	µ
	Average (mean)	2683.38	
	Standard Deviation (σ)	3.81	
	% Relative Standard Deviation (RSD)	0.14	
6	2 Points	1789.85	µ
7	2 Points	1801.52	µ
8	2 Points	1799.82	µ
9	2 Points	1813.02	µ
10	2 Points	1799.94	µ
	Average (mean)	1800.83	
	Standard Deviation (σ)	8.24	
	% Relative Standard Deviation (RSD)	0.46	
11	2 Points	1736.26	µ
12	2 Points	1736.26	µ
13	2 Points	1736.64	µ
14	2 Points	1725.06	µ
15	2 Points	1715.36	µ
	Average (mean)	1729.92	
	Standard Deviation (σ)	9.50	
	% Relative Standard Deviation (RSD)	0.55	
16	2 Points	1862.32	µ
17	2 Points	1856.45	µ
18	2 Points	1855.6	µ
19	2 Points	1851.15	µ
20	2 Points	1863	µ
	Average (mean)	1857.70	
	Standard Deviation (σ)	4.96	
	% Relative Standard Deviation (RSD)	0.27	
21	2 Points	1696.29	µ
22	2 Points	1687.82	µ
23	2 Points	1679.14	µ
24	2 Points	1672.53	µ
25	2 Points	1686.91	µ
	Average (mean)	1684.54	
	Standard Deviation (σ)	9.05	
	% Relative Standard Deviation (RSD)	0.54	

After treatment

Title	Measurement Result			
Date saved	5/1/2017	12:46 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	2682.5	µ	
2	2 Points	2686.09	µ	
3	2 Points	2683.63	µ	
4	2 Points	2677.59	µ	
5	2 Points	2678.02	µ	
	Average (mean)	2681.57		-0.54
	Standard Deviation (σ)	3.67		
	% Relative Standard Deviation (RSD)	0.14		
6	2 Points	1780.08	µ	
7	2 Points	1792.5	µ	
8	2 Points	1790.08	µ	
9	2 Points	1788.85	µ	
10	2 Points	1780.54	µ	
	Average (mean)	1786.41		-1.30
	Standard Deviation (σ)	5.72		
	% Relative Standard Deviation (RSD)	0.32		
11	2 Points	1738.36	µ	
12	2 Points	1748.92	µ	
13	2 Points	1755.28	µ	
14	2 Points	1756.06	µ	
15	2 Points	1734.28	µ	
	Average (mean)	1746.58		0.41
	Standard Deviation (σ)	9.87		
	% Relative Standard Deviation (RSD)	0.57		
16	2 Points	1866.29	µ	
17	2 Points	1869.93	µ	
18	2 Points	1872.75	µ	
19	2 Points	1877.53	µ	
20	2 Points	1874.82	µ	
	Average (mean)	1872.26		1.34
	Standard Deviation (σ)	4.35		
	% Relative Standard Deviation (RSD)	0.23		
21	2 Points	1696.55	µ	
22	2 Points	1690.29	µ	
23	2 Points	1691.93	µ	
24	2 Points	1685.51	µ	
25	2 Points	1693.16	µ	
	Average (mean)	1691.49		-3.23
	Standard Deviation (σ)	4.06		
	% Relative Standard Deviation (RSD)	0.24		
	Average % change			-0.67

Willow - Basketry Sample (control) - Measurements before, during and after humidification

Before treatment

Spot on sample	Title	Measurement Result		
	Date saved	5/10/2017	2:34 PM	
	No.	Measure	Result	Unit
	1	2 Points	1507.63	µm
	2	2 Points	1513.96	µm
	3	2 Points	1501.43	µm
	4	2 Points	1496.95	µm
	5	2 Points	1507.61	µm
	6	2 Points	1499.11	µm
Spot # 1 Split sample	7	2 Points	1503.4	µm
	8	2 Points	1507.56	µm
	9	2 Points	1501.19	µm
	10	2 Points	1503.46	µm
		Average (mean)	1504.23	
		Standard Deviation (σ)	5.01	
		% Relative Standard Deviation (%RSD)	0.33	
	11	2 Points	1494.83	µm
	12	2 Points	1488.56	µm
	13	2 Points	1490.59	µm
	14	2 Points	1490.68	µm
	15	2 Points	1471.5	µm
	16	2 Points	1492.69	µm
Spot # 2 Split sample	17	2 Points	1490.64	µm
	18	2 Points	1492.84	µm
	19	2 Points	1494.86	µm
	20	2 Points	1490.74	µm
		Average (mean)	1489.79	
		Standard Deviation (σ)	6.73	
		% Relative Standard Deviation (%RSD)	0.45	
	21	2 Points	1469.38	µm
	22	2 Points	1473.96	µm
	23	2 Points	1469.62	µm
	24	2 Points	1471.5	µm
	25	2 Points	1478.04	µm
	26	2 Points	1471.6	µm
Spot # 3 Split sample	27	2 Points	1473.67	µm
	28	2 Points	1473.87	µm
	29	2 Points	1471.47	µm
	30	2 Points	1473.6	µm
		Average (mean)	1472.67	
		Standard Deviation (σ)	2.54	
		% Relative Standard Deviation (%RSD)	0.17	
	31	2 Points	1460.95	µm
	32	2 Points	1463.14	µm
	33	2 Points	1465.17	µm
	34	2 Points	1454.81	µm
	35	2 Points	1465.38	µm
	36	2 Points	1467.3	µm
Spot # 4 Split sample	37	2 Points	1469.42	µm
	38	2 Points	1465.15	µm
	39	2 Points	1460.85	µm
	40	2 Points	1460.83	µm
		Average (mean)	1463.30	
		Standard Deviation (σ)	4.14	
		% Relative Standard Deviation (%RSD)	0.28	
	41	2 Points	1462.31	µm
	42	2 Points	1472.48	µm
	43	2 Points	1468.49	µm
	44	2 Points	1463.99	µm
	45	2 Points	1464.16	µm
	46	2 Points	1460.09	µm
Spot # 5 Split sample	47	2 Points	1473.32	µm
	48	2 Points	1464.73	µm
	49	2 Points	1461.64	µm
	50	2 Points	1455.42	µm
		Average (mean)	1464.66	
		Standard Deviation (σ)	5.50	

During treatment

Title	Measurement Result		
Date saved	5/16/2017	2:56 PM	
No.	Measure	Result	Unit
1	2 Points	1489.11	µm
2	2 Points	1491.46	µm
3	2 Points	1488.86	µm
4	2 Points	1485.17	µm
5	2 Points	1491.71	µm
6	2 Points	1491.1	µm
7	2 Points	1493.43	µm
8	2 Points	1489.68	µm
9	2 Points	1487.38	µm
10	2 Points	1489.26	µm
	Average (mean)	1489.72	
	Standard Deviation (σ)	2.36	
	% Relative Standard Deviation (%RSD)	0.16	
11	2 Points	1474.33	µm
12	2 Points	1465.64	µm
13	2 Points	1469.76	µm
14	2 Points	1467.34	µm
15	2 Points	1472.44	µm
16	2 Points	1469.55	µm
17	2 Points	1469.51	µm
18	2 Points	1469.82	µm
19	2 Points	1466.25	µm
20	2 Points	1466.16	µm
	Average (mean)	1469.08	
	Standard Deviation (σ)	2.82	
	% Relative Standard Deviation (%RSD)	0.19	
21	2 Points	1465.26	µm
22	2 Points	1465.57	µm
23	2 Points	1469.95	µm
24	2 Points	1458.85	µm
25	2 Points	1448.42	µm
26	2 Points	1465.4	µm
27	2 Points	1461.67	µm
28	2 Points	1460.84	µm
29	2 Points	1463.45	µm
30	2 Points	1460.79	µm
	Average (mean)	1462.02	
	Standard Deviation (σ)	5.75	
	% Relative Standard Deviation (%RSD)	0.39	
31	2 Points	1459.48	µm
32	2 Points	1457.86	µm
33	2 Points	1462.19	µm
34	2 Points	1461.53	µm
35	2 Points	1457.02	µm
36	2 Points	1453.27	µm
37	2 Points	1462.19	µm
38	2 Points	1462.82	µm
39	2 Points	1457.86	µm
40	2 Points	1460.7	µm
	Average (mean)	1459.49	
	Standard Deviation (σ)	3.01	
	% Relative Standard Deviation (%RSD)	0.21	
41	2 Points	1454.84	µm
42	2 Points	1456.54	µm
43	2 Points	1461.06	µm
44	2 Points	1450.22	µm
45	2 Points	1458.77	µm
46	2 Points	1458.71	µm
47	2 Points	1461.01	µm
48	2 Points	1456.65	µm
49	2 Points	1452.67	µm
50	2 Points	1459.09	µm
	Average (mean)	1456.96	
	Standard Deviation (σ)	3.54	

After treatment

Title	Measurement Result			
Date saved	5/18/2017	3:44 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	1499.11	µm	
2	2 Points	1497.11	µm	
3	2 Points	1496.99	µm	
4	2 Points	1501.2	µm	
5	2 Points	1496.95	µm	
6	2 Points	1492.86	µm	
7	2 Points	1496.99	µm	
8	2 Points	1499.33	µm	
9	2 Points	1497.31	µm	
10	2 Points	1497.2	µm	
	Average (mean)	1497.51		-0.45
	Standard Deviation (σ)	2.17		
	% Relative Standard Deviation (%RSD)	0.14		
11	2 Points	1486.15	µm	
12	2 Points	1486.19	µm	
13	2 Points	1481.91	µm	
14	2 Points	1484.42	µm	
15	2 Points	1484.03	µm	
16	2 Points	1484.05	µm	
17	2 Points	1481.91	µm	
18	2 Points	1481.92	µm	
19	2 Points	1481.93	µm	
20	2 Points	1484.03	µm	
	Average (mean)	1483.65		-0.41
	Standard Deviation (σ)	1.69		
	% Relative Standard Deviation (%RSD)	0.11		
21	2 Points	1469.24	µm	
22	2 Points	1471.29	µm	
23	2 Points	1469.17	µm	
24	2 Points	1467.08	µm	
25	2 Points	1469.24	µm	
26	2 Points	1465.04	µm	
27	2 Points	1467.12	µm	
28	2 Points	1471.34	µm	
29	2 Points	1464.92	µm	
30	2 Points	1467.08	µm	
	Average (mean)	1468.15		-0.31
	Standard Deviation (σ)	2.28		
	% Relative Standard Deviation (%RSD)	0.16		
31	2 Points	1463.19	µm	
32	2 Points	1467.26	µm	
33	2 Points	1471.63	µm	
34	2 Points	1465.36	µm	
35	2 Points	1469.35	µm	
36	2 Points	1473.8	µm	
37	2 Points	1469.29	µm	
38	2 Points	1473.8	µm	
39	2 Points	1469.56	µm	
40	2 Points	1475.59	µm	
	Average (mean)	1469.88		0.45
	Standard Deviation (σ)	3.93		
	% Relative Standard Deviation (%RSD)	0.27		
41	2 Points	1472.03	µm	
42	2 Points	1474.37	µm	
43	2 Points	1474.37	µm	
44	2 Points	1478.27	µm	
45	2 Points	1476.09	µm	
46	2 Points	1476.65	µm	
47	2 Points	1476.57	µm	
48	2 Points	1469.84	µm	
49	2 Points	1473.71	µm	
50	2 Points	1474.09	µm	
	Average (mean)	1474.60		0.68
	Standard Deviation (σ)	2.45		

		% Relative Standard Deviation (%RSD)	0.38	

	% Relative Standard Deviation (%RSD)	0.24	

	% Relative Standard Deviation (%RSD)	0.17		
	Average % change			-0.01

Willow - Non-Basketry Sample 2 (H$_2$0) - Measurements before, during and after humidification

Before treatment

Area on sample	Title	Measurement Result		
	Date saved	5/10/2017	3:08 PM	
	No.	Measure	Result	Unit
	1	2 Points	1964	µm
	2	2 Points	1972.59	µm
	3	2 Points	1968.37	µm
	4	2 Points	1968.4	µm
	5	2 Points	1976.79	µm
	6	2 Points	1977.15	µm
Spot # 1 Split sample	7	2 Points	1968.57	µm
	8	2 Points	1964.37	µm
	9	2 Points	1965.06	µm
	10	2 Points	1971.22	µm
		Average (mean)	1969.65	
		Standard Deviation (σ)	4.76	
		% Relative Standard Deviation (%RSD)	0.24	
	11	2 Points	2066.4	µm
	12	2 Points	2076.85	µm
	13	2 Points	2066.36	µm
	14	2 Points	2065.97	µm
	15	2 Points	2062.61	µm
	16	2 Points	2064.11	µm
Spot # 2 Split sample	17	2 Points	2062.11	µm
	18	2 Points	2068.39	µm
	19	2 Points	2063.89	µm
	20	2 Points	2061.67	µm
		Average (mean)	2065.84	
		Standard Deviation (σ)	4.43	
		% Relative Standard Deviation (%RSD)	0.21	
	21	2 Points	2050.56	µm
	22	2 Points	2054.64	µm
	23	2 Points	2049.58	µm
	24	2 Points	2037.08	µm
	25	2 Points	2047.69	µm
	26	2 Points	2052.21	µm
Spot # 3 Split sample	27	2 Points	2053.82	µm
	28	2 Points	2047.82	µm
	29	2 Points	2030.59	µm
	30	2 Points	2052.52	µm
		Average (mean)	2047.65	
		Standard Deviation (σ)	7.79	
		% Relative Standard Deviation (%RSD)	0.38	
	31	2 Points	2017.08	µm
	32	2 Points	2026.53	µm
	33	2 Points	2029.18	µm
	34	2 Points	2034.56	µm
	35	2 Points	2032.9	µm
	36	2 Points	2031.14	µm
Spot # 4 Split sample	37	2 Points	2023.44	µm
	38	2 Points	2024.53	µm
	39	2 Points	2019.94	µm
	40	2 Points	2036.27	µm
		Average (mean)	2027.56	
		Standard Deviation (σ)	6.36	
		% Relative Standard Deviation (%RSD)	0.31	
	41	2 Points	1876.96	µm
	42	2 Points	1879.12	µm
	43	2 Points	1864.19	µm
	44	2 Points	1876.91	µm
	45	2 Points	1876.92	µm
	46	2 Points	1872.71	µm
Spot # 5	47	2 Points	1874.83	µm

During treatment

Title	Measurement Result		
Date saved	5/16/2017	4:30 PM	
No.	Measure	Result	Unit
1	2 Points	2049.32	µm
2	2 Points	2049.38	µm
3	2 Points	2045.47	µm
4	2 Points	2047.55	µm
5	2 Points	2040.17	µm
6	2 Points	2055.68	µm
7	2 Points	2041.8	µm
8	2 Points	2040.15	µm
9	2 Points	2035.11	µm
10	2 Points	2035.66	µm
	Average (mean)	2044.03	
	Standard Deviation (σ)	6.59	
	% Relative Standard Deviation (%RSD)	0.32	
11	2 Points	2157.5	µm
12	2 Points	2162.63	µm
13	2 Points	2164.64	µm
14	2 Points	2156.91	µm
15	2 Points	2166.35	µm
16	2 Points	2155.44	µm
17	2 Points	2174.62	µm
18	2 Points	2183.71	µm
19	2 Points	2166.17	µm
20	2 Points	2177.01	µm
	Average (mean)	2166.50	
	Standard Deviation (σ)	9.35	
	% Relative Standard Deviation (%RSD)	0.43	
21	2 Points	2153.32	µm
22	2 Points	2148.19	µm
23	2 Points	2153.59	µm
24	2 Points	2151.76	µm
25	2 Points	2161.56	µm
26	2 Points	2137.93	µm
27	2 Points	2147.13	µm
28	2 Points	2152.49	µm
29	2 Points	2143.03	µm
30	2 Points	2159.48	µm
	Average (mean)	2150.85	
	Standard Deviation (σ)	7.11	
	% Relative Standard Deviation (%RSD)	0.33	
31	2 Points	2118.36	µm
32	2 Points	2129.12	µm
33	2 Points	2135.79	µm
34	2 Points	2136.56	µm
35	2 Points	2138.88	µm
36	2 Points	2126.71	µm
37	2 Points	2137.85	µm
38	2 Points	2134.65	µm
39	2 Points	2122.71	µm
40	2 Points	2136.44	µm
	Average (mean)	2131.71	
	Standard Deviation (σ)	7.08	
	% Relative Standard Deviation (%RSD)	0.33	
41	2 Points	1915.24	µm
42	2 Points	1940.59	µm
43	2 Points	1949.53	µm
44	2 Points	1946.03	µm
45	2 Points	1951.07	µm
46	2 Points	1963.54	µm
47	2 Points	1949.97	µm

After treatment

Title	Measurement Result			
Date saved	5/18/2017	4:17 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	1988.51	µm	
2	2 Points	2004.87	µm	
3	2 Points	1997.16	µm	
4	2 Points	1998.12	µm	
5	2 Points	2008.5	µm	
6	2 Points	1998.32	µm	
7	2 Points	1992.81	µm	
8	2 Points	1998.73	µm	
9	2 Points	2001.47	µm	
10	2 Points	1992.39	µm	
	Average (mean)	1998.09		1.44
	Standard Deviation (σ)	5.96		
	% Relative Standard Deviation (%RSD)	0.30		
11	2 Points	2117.81	µm	
12	2 Points	2118.4	µm	
13	2 Points	2130.06	µm	
14	2 Points	2118.6	µm	
15	2 Points	2126.27	µm	
16	2 Points	2128.34	µm	
17	2 Points	2129.13	µm	
18	2 Points	2126.24	µm	
19	2 Points	2118.86	µm	
20	2 Points	2119.4	µm	
	Average (mean)	2123.31		2.78
	Standard Deviation (σ)	5.10		
	% Relative Standard Deviation (%RSD)	0.24		
21	2 Points	2114.45	µm	
22	2 Points	2109.31	µm	
23	2 Points	2111.42	µm	
24	2 Points	2113.3	µm	
25	2 Points	2113.3	µm	
26	2 Points	2112.98	µm	
27	2 Points	2117.02	µm	
28	2 Points	2112.35	µm	
29	2 Points	2124.43	µm	
30	2 Points	2124.02	µm	
	Average (mean)	2115.26		3.30
	Standard Deviation (σ)	5.12		
	% Relative Standard Deviation (%RSD)	0.24		
31	2 Points	2087.15	µm	
32	2 Points	2094.61	µm	
33	2 Points	2085.6	µm	
34	2 Points	2102.8	µm	
35	2 Points	2094.08	µm	
36	2 Points	2103.45	µm	
37	2 Points	2112.98	µm	
38	2 Points	2093.69	µm	
39	2 Points	2102.8	µm	
40	2 Points	2096.5	µm	
	Average (mean)	2097.37		3.44
	Standard Deviation (σ)	8.27		
	% Relative Standard Deviation (%RSD)	0.39		
41	2 Points	1887.94	µm	
42	2 Points	1891.68	µm	
43	2 Points	1884.82	µm	
44	2 Points	1895.08	µm	
45	2 Points	1890.47	µm	
46	2 Points	1885.33	µm	
47	2 Points	1885.33	µm	

Split sample	48	2 Points	1874.77	µm		48	2 Points	1959.97	µm		48	2 Points	1890.1	µm		
	49	2 Points	1872.8	µm		49	2 Points	1952.37	µm		49	2 Points	1898.56	µm		
	50	2 Points	1877.17	µm		50	2 Points	1945.74	µm		50	2 Points	1889.11	µm		
		Average (mean)	1874.64				Average (mean)	1947.41				Average (mean)	1889.84			0.81
		Standard Deviation (σ)	4.20				Standard Deviation (σ)	13.14				Standard Deviation (σ)	4.44			
		% Relative Standard Deviation (%RSD)	0.22				% Relative Standard Deviation (%RSD)	0.67				% Relative Standard Deviation (%RSD)	0.23			
												Average % change				2.36

Willow - Basketry Sample (ethanol) - Measurements before, during and after humidification

	Before treatment				During treatment				After treatment				
Spot on sample	**Title**	**Measurement Result**			**Title**	**Measurement Result**			**Title**	**Measurement Result**			
	Date saved	5/10/2017	3:36 PM		**Date saved**	5/16/2017	5:05 PM		**Date saved**	5/18/2017	4:46 PM		
	No.	**Measure**	**Result**	**Unit**	**No.**	**Measure**	**Result**	**Unit**	**No.**	**Measure**	**Result**	**Unit**	**% Change**
	1	2 Points	2235.85	µm	**1**	2 Points	2219.2	µm	**1**	2 Points	2240.39	µm	
	2	2 Points	2238	µm	**2**	2 Points	2228.1	µm	**2**	2 Points	2240.39	µm	
	3	2 Points	2229.84	µm	**3**	2 Points	2227.54	µm	**3**	2 Points	2242.51	µm	
	4	2 Points	2238	µm	**4**	2 Points	2223.12	µm	**4**	2 Points	2243.99	µm	
	5	2 Points	2233.89	µm	**5**	2 Points	2230.36	µm	**5**	2 Points	2241.87	µm	
	6	2 Points	2229.56	µm	**6**	2 Points	2223.86	µm	**6**	2 Points	2236.67	µm	
Spot # 1 Split sample	**7**	2 Points	2235.99	µm	**7**	2 Points	2234.45	µm	**7**	2 Points	2244.79	µm	
	8	2 Points	2237.98	µm	**8**	2 Points	2220.21	µm	**8**	2 Points	2240.56	µm	
	9	2 Points	2235.87	µm	**9**	2 Points	2229.13	µm	**9**	2 Points	2244.79	µm	
	10	2 Points	2235.92	µm	**10**	2 Points	2231.64	µm	**10**	2 Points	2237.79	µm	
		Average (mean)	2235.09			Average (mean)	2226.76			Average (mean)	2241.38		0.28
		Standard Deviation (σ)	3.12			Standard Deviation (σ)	5.01			Standard Deviation (σ)	2.77		
		% Relative Standard Deviation (%RSD)	0.14			% Relative Standard Deviation (%RSD)	0.22			% Relative Standard Deviation (%RSD)	0.12		
	11	2 Points	2242.23	µm	**11**	2 Points	2247.75	µm	**11**	2 Points	2267.76	µm	
	12	2 Points	2252.86	µm	**12**	2 Points	2239.11	µm	**12**	2 Points	2259.45	µm	
	13	2 Points	2246.48	µm	**13**	2 Points	2250.97	µm	**13**	2 Points	2258.81	µm	
	14	2 Points	2248.6	µm	**14**	2 Points	2242.66	µm	**14**	2 Points	2254.73	µm	
	15	2 Points	2250.83	µm	**15**	2 Points	2245.93	µm	**15**	2 Points	2257.33	µm	
	16	2 Points	2242.38	µm	**16**	2 Points	2233.87	µm	**16**	2 Points	2265.8	µm	
Spot # 2 Split sample	**17**	2 Points	2242.31	µm	**17**	2 Points	2256.22	µm	**17**	2 Points	2268.08	µm	
	18	2 Points	2242.24	µm	**18**	2 Points	2241.7	µm	**18**	2 Points	2262.74	µm	
	19	2 Points	2237.99	µm	**19**	2 Points	2250.01	µm	**19**	2 Points	2268.25	µm	
	20	2 Points	2238.03	µm	**20**	2 Points	2243.51	µm	**20**	2 Points	2266.64	µm	
		Average (mean)	2244.40			Average (mean)	2245.17			Average (mean)	2262.96		0.83
		Standard Deviation (σ)	5.10			Standard Deviation (σ)	6.43			Standard Deviation (σ)	5.03		
		% Relative Standard Deviation (%RSD)	0.23			% Relative Standard Deviation (%RSD)	0.29			% Relative Standard Deviation (%RSD)	0.22		
	21	2 Points	2246.49	µm	**21**	2 Points	2258.46	µm	**21**	2 Points	2259.61	µm	
	22	2 Points	2246.6	µm	**22**	2 Points	2254.56	µm	**22**	2 Points	2249.03	µm	
	23	2 Points	2238	µm	**23**	2 Points	2259.43	µm	**23**	2 Points	2259.95	µm	
	24	2 Points	2242.47	µm	**24**	2 Points	2259.43	µm	**24**	2 Points	2266.3	µm	
	25	2 Points	2235.85	µm	**25**	2 Points	2269.7	µm	**25**	2 Points	2263.36	µm	
	26	2 Points	2240.11	µm	**26**	2 Points	2263.35	µm	**26**	2 Points	2262.15	µm	
Spot # 3 Split sample	**27**	2 Points	2240.12	µm	**27**	2 Points	2254.46	µm	**27**	2 Points	2269.4	µm	
	28	2 Points	2250.72	µm	**28**	2 Points	2259.77	µm	**28**	2 Points	2271.83	µm	
	29	2 Points	2235.87	µm	**29**	2 Points	2249.35	µm	**29**	2 Points	2260.62	µm	
	30	2 Points	2233.75	µm	**30**	2 Points	2249.7	µm	**30**	2 Points	2263.85	µm	
		Average (mean)	2241.00			Average (mean)	2257.82			Average (mean)	2262.61		0.96
		Standard Deviation (σ)	5.52			Standard Deviation (σ)	6.15			Standard Deviation (σ)	6.25		
		% Relative Standard Deviation (%RSD)	0.25			% Relative Standard Deviation (%RSD)	0.27			% Relative Standard Deviation (%RSD)	0.28		
	31	2 Points	2261.33	µm	**31**	2 Points	2265.01	µm	**31**	2 Points	2275.91	µm	
	32	2 Points	2263.45	µm	**32**	2 Points	2258.27	µm	**32**	2 Points	2275.15	µm	
	33	2 Points	2265.57	µm	**33**	2 Points	2258.67	µm	**33**	2 Points	2277.12	µm	
	34	2 Points	2250.74	µm	**34**	2 Points	2243.88	µm	**34**	2 Points	2277.57	µm	
	35	2 Points	2257.14	µm	**35**	2 Points	2258.45	µm	**35**	2 Points	2272.89	µm	
	36	2 Points	2254.95	µm	**36**	2 Points	2253.37	µm	**36**	2 Points	2262.44	µm	
Spot # 4 Split sample	**37**	2 Points	2263.46	µm	**37**	2 Points	2259.49	µm	**37**	2 Points	2286.34	µm	
	38	2 Points	2257.14	µm	**38**	2 Points	2263.3	µm	**38**	2 Points	2286.5	µm	
	39	2 Points	2248.59	µm	**39**	2 Points	2261.61	µm	**39**	2 Points	2280.8	µm	
	40	2 Points	2257.11	µm	**40**	2 Points	2272.81	µm	**40**	2 Points	2283.48	µm	
		Average (mean)	2257.95			Average (mean)	2259.49			Average (mean)	2277.82		0.88
		Standard Deviation (σ)	5.58			Standard Deviation (σ)	7.54			Standard Deviation (σ)	7.16		
		% Relative Standard Deviation (%RSD)	0.25			% Relative Standard Deviation (%RSD)	0.33			% Relative Standard Deviation (%RSD)	0.31		
	41	2 Points	2195.6	µm	**41**	2 Points	2245.98	µm	**41**	2 Points	2257.77	µm	
	42	2 Points	2214.73	µm	**42**	2 Points	2240.47	µm	**42**	2 Points	2260	µm	
	43	2 Points	2204.32	µm	**43**	2 Points	2244.08	µm	**43**	2 Points	2266.14	µm	
	44	2 Points	2201.92	µm	**44**	2 Points	2241.28	µm	**44**	2 Points	2259.47	µm	
	45	2 Points	2204.14	µm	**45**	2 Points	2254.23	µm	**45**	2 Points	2250.99	µm	
	46	2 Points	2204.03	µm	**46**	2 Points	2253.36	µm	**46**	2 Points	2261.4	µm	
Spot # 5 Split sample	**47**	2 Points	2197.85	µm	**47**	2 Points	2246.91	µm	**47**	2 Points	2255.04	µm	
	48	2 Points	2198.12	µm	**48**	2 Points	2256.52	µm	**48**	2 Points	2259.28	µm	
	49	2 Points	2206.29	µm	**49**	2 Points	2242	µm	**49**	2 Points	2266.58	µm	
	50	2 Points	2200.24	µm	**50**	2 Points	2237.06	µm	**50**	2 Points	2270.28	µm	

		Average (mean)	2202.72	
		Standard Deviation (σ)	5.43	
		% Relative Standard Deviation (%RSD)	0.25	

	Average (mean)	2246.19	
	Standard Deviation (σ)	6.54	
	% Relative Standard Deviation (%RSD)	0.29	

	Average (mean)	2260.70		2.63
	Standard Deviation (σ)	5.73		
	% Relative Standard Deviation (%RSD)	0.25		
	Average % change			1.12

Willow - Basketry Sample, cross section (control) - Measurements before, during and after humidification

Before treatment

	Title	Measurement Result		
	Date saved	5/10/2017	2:39 PM	
	No.	**Measure**	**Result**	**Unit**
	1	2 Points	1466.92	µm
	2	2 Points	1467.81	µm
	3	2 Points	1467.96	µm
	4	2 Points	1465.89	µm
	5	2 Points	1467.96	µm
	6	2 Points	1467.96	µm
	7	2 Points	1468.85	µm
	8	2 Points	1467.96	µm
	9	2 Points	1473.59	µm
	10	2 Points	1466.78	µm
		Average (mean)	1468.17	
		Standard Deviation (σ)	2.08	
		% Relative Standard Deviation (%RSD)	0.14	
	11	2 Points	1781.73	µm
	12	2 Points	1786.47	µm
	13	2 Points	1785.17	µm
	14	2 Points	1788.11	µm
	15	2 Points	1786.16	µm
	16	2 Points	1782.55	µm
	17	2 Points	1785.65	µm
	18	2 Points	1785.65	µm
	19	2 Points	1782.06	µm
	20	2 Points	1784.02	µm
		Average (mean)	1784.76	
		Standard Deviation (σ)	2.10	
		% Relative Standard Deviation (%RSD)	0.12	
	21	*(Corrupted data file)*		
	22	*(Corrupted data file)*		
	23	*(Corrupted data file)*		
	24	*(Corrupted data file)*		
	25	*(Corrupted data file)*		
	26	*(Corrupted data file)*		
	27	*(Corrupted data file)*		
	28	*(Corrupted data file)*		
	29	*(Corrupted data file)*		
	30	*(Corrupted data file)*		
		Average (mean)		
		Standard Deviation (σ)		
		% Relative Standard Deviation (%RSD)		

During treatment

Title	Measurement Result		
Date saved	5/16/2017	3:00 PM	
No.	**Measure**	**Result**	**Unit**
1	2 Points	1461.74	µm
2	2 Points	1462.64	µm
3	2 Points	1458.88	µm
4	2 Points	1460.76	µm
5	2 Points	1462.64	µm
6	2 Points	1460.76	µm
7	2 Points	1457.9	µm
8	2 Points	1458.88	µm
9	2 Points	1457.98	µm
10	2 Points	1461.66	µm
	Average (mean)	1460.38	
	Standard Deviation (σ)	1.84	
	% Relative Standard Deviation (%RSD)	0.13	
11	2 Points	1794.29	µm
12	2 Points	1794.11	µm
13	2 Points	1793.23	µm
14	2 Points	1793.23	µm
15	2 Points	1793.06	µm
16	2 Points	1793.94	µm
17	2 Points	1794.99	µm
18	2 Points	1796.92	µm
19	2 Points	1793.94	µm
20	2 Points	1790.08	µm
	Average (mean)	1793.78	
	Standard Deviation (σ)	1.72	
	% Relative Standard Deviation (%RSD)	0.10	
21	~~2 Points~~	~~1806.8~~	µm
22	~~2 Points~~	~~1806.57~~	µm
23	~~2 Points~~	~~1805.32~~	µm
24	~~2 Points~~	~~1804.58~~	µm
25	~~2 Points~~	~~1808.05~~	µm
26	~~2 Points~~	~~1806.06~~	µm
27	~~2 Points~~	~~1811.52~~	µm
28	~~2 Points~~	~~1806.8~~	µm
29	~~2 Points~~	~~1816.01~~	µm
30	~~2 Points~~	~~1812.03~~	µm
	Average (mean)	1808.37	
	Standard Deviation (σ)	3.64	
	% Relative Standard Deviation (%RSD)	0.20	

After treatment

Title	Measurement Result			
Date saved	5/18/2017	3:48 PM		
No.	**Measure**	**Result**	**Unit**	**% Change**
1	2 Points	1471.05	µm	
2	2 Points	1470.08	µm	
3	2 Points	1475.76	µm	
4	2 Points	1473.87	µm	
5	2 Points	1473.87	µm	
6	2 Points	1475.76	µm	
7	2 Points	1472.94	µm	
8	2 Points	1467.23	µm	
9	2 Points	1471.02	µm	
10	2 Points	1471.02	µm	
	Average (mean)	1472.26		0.28
	Standard Deviation (σ)	2.68		
	% Relative Standard Deviation (%RSD)	0.18		
11	2 Points	1793.65	µm	
12	2 Points	1792.62	µm	
13	2 Points	1792.62	µm	
14	2 Points	1793.52	µm	
15	2 Points	1792.62	µm	
16	2 Points	1792.62	µm	
17	2 Points	1792.75	µm	
18	2 Points	1789.93	µm	
19	2 Points	1790.83	µm	
20	2 Points	1790.83	µm	
	Average (mean)	1792.20		0.42
	Standard Deviation (σ)	1.24		
	% Relative Standard Deviation (%RSD)	0.07		
21	~~2 Points~~	~~1811.5~~	µm	
22	~~2 Points~~	~~1812.28~~	µm	
23	~~2 Points~~	~~1810.73~~	µm	
24	~~2 Points~~	~~1809.95~~	µm	
25	~~2 Points~~	~~1812.7~~	µm	
26	~~2 Points~~	~~1813.48~~	µm	
27	~~2 Points~~	~~1809.53~~	µm	
28	~~2 Points~~	~~1806.77~~	µm	
29	~~2 Points~~	~~1807.2~~	µm	
30	~~2 Points~~	~~1811.5~~	µm	
	Average (mean)	1810.56		
	Standard Deviation (σ)	2.23		
	% Relative Standard Deviation (%RSD)	0.12		
	Average % Change			0.35

Willow - Basketry Sample 2, cross section (H_20) - Measurements before, during and after humidification

Before treatment

Title	Measurement Result		
Date saved	5/10/2017	3:11 PM	
No.	Measure	Result	Unit
1	2 Points	1715.26	µm
2	2 Points	1715.26	µm
3	2 Points	1716.84	µm
4	2 Points	1718.43	µm
5	2 Points	1721.2	µm
6	2 Points	1720.4	µm
7	2 Points	1716.84	µm
8	2 Points	1717.63	µm
9	2 Points	1719.6	µm
10	2 Points	1718.02	µm
	Average (mean)	1717.95	
	Standard Deviation (σ)	2.02	
	% Relative Standard Deviation (%RSD)	0.12	
11	2 Points	1873.76	µm
12	2 Points	1870.42	µm
13	2 Points	1873.11	µm
14	2 Points	1871.75	µm
15	2 Points	1867.71	µm
16	2 Points	1867.73	µm
17	2 Points	1871.79	µm
18	2 Points	1871.1	µm
19	2 Points	1865.04	µm
20	2 Points	1865.72	µm
	Average (mean)	1869.81	
	Standard Deviation (σ)	3.06	
	% Relative Standard Deviation (%RSD)	0.16	
21	2 Points	1443.37	µm
22	2 Points	1441.97	µm
23	2 Points	1443.57	µm
24	2 Points	1445.18	µm
25	2 Points	1446.36	µm
26	2 Points	1442.97	µm
27	2 Points	1443.57	µm
28	2 Points	1439.19	µm
29	2 Points	1443.17	µm
30	2 Points	1444.38	µm
	Average (mean)	1443.37	
	Standard Deviation (σ)	1.91	
	% Relative Standard Deviation (%RSD)	0.13	

During treatment

Title	Measurement Result		
Date saved	5/16/2017	4:36 PM	
No.	Measure	Result	Unit
1	2 Points	1740.23	µm
2	2 Points	1741.63	µm
3	2 Points	1738.36	µm
4	2 Points	1743.04	µm
5	2 Points	1742.42	µm
6	2 Points	1742.42	µm
7	2 Points	1743.04	µm
8	2 Points	1745.07	µm
9	2 Points	1745.07	µm
10	2 Points	1751.63	µm
	Average (mean)	1743.29	
	Standard Deviation (σ)	3.56	
	% Relative Standard Deviation (%RSD)	0.20	
11	2 Points	1904.63	µm
12	2 Points	1903.91	µm
13	2 Points	1899.19	µm
14	2 Points	1902.64	µm
15	2 Points	1903.91	µm
16	2 Points	1904.63	µm
17	2 Points	1899.37	µm
18	2 Points	1899.92	µm
19	2 Points	1903.91	µm
20	2 Points	1902.64	µm
	Average (mean)	1902.48	
	Standard Deviation (σ)	2.17	
	% Relative Standard Deviation (%RSD)	0.11	
21	2 Points	1465.19	µm
22	2 Points	1466.15	µm
23	2 Points	1466.36	µm
24	2 Points	1461.98	µm
25	2 Points	1460.37	µm
26	2 Points	1470.54	µm
27	2 Points	1469.36	µm
28	2 Points	1463.81	µm
29	2 Points	1467.75	µm
30	2 Points	1466.15	µm
	Average (mean)	1465.77	
	Standard Deviation (σ)	3.13	
	% Relative Standard Deviation (%RSD)	0.21	

After treatment

Title	Measurement Result			
Date saved	5/18/2017	4:20 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	1731.76	µm	
2	2 Points	1731.09	µm	
3	2 Points	1727.73	µm	
4	2 Points	1727.06	µm	
5	2 Points	1729.07	µm	
6	2 Points	1731.09	µm	
7	2 Points	1729.1	µm	
8	2 Points	1729.1	µm	
9	2 Points	1730.42	µm	
10	2 Points	1731.09	µm	
	Average (mean)	1729.75		0.69
	Standard Deviation (σ)	1.58		
	% Relative Standard Deviation (%RSD)	0.09		
11	2 Points	1860.3	µm	
12	2 Points	1863.14	µm	
13	2 Points	1861.72	µm	
14	2 Points	1861.72	µm	
15	2 Points	1860.3	µm	
16	2 Points	1863.14	µm	
17	2 Points	1863.14	µm	
18	2 Points	1861.72	µm	
19	2 Points	1861.1	µm	
20	2 Points	1861.31	µm	
	Average (mean)	1861.76		-0.43
	Standard Deviation (σ)	1.09		
	% Relative Standard Deviation (%RSD)	0.06		
21	2 Points	1470.91	µm	
22	2 Points	1469.23	µm	
23	2 Points	1472.6	µm	
24	2 Points	1468.34	µm	
25	2 Points	1474.29	µm	
26	2 Points	1472.6	µm	
27	2 Points	1469.23	µm	
28	2 Points	1468.34	µm	
29	2 Points	1468.34	µm	
30	2 Points	1472.2	µm	
	Average (mean)	1470.61		1.89
	Standard Deviation (σ)	2.19		
	% Relative Standard Deviation (%RSD)	0.15		
	Average % Change			0.71

Willow - Basketry Sample, cross section (ethanol) - Measurements before, during and after humidification

Before treatment

Title	Measurement Result		
Date saved	5/10/2017	3:40 PM	
No.	Measure	Result	Unit
1	2 Points	1413.3	µm
2	2 Points	1415.33	µm
3	2 Points	1415.16	µm
4	2 Points	1413.12	µm
5	2 Points	1411	µm
6	2 Points	1415.6	µm
7	2 Points	1415.33	µm
8	2 Points	1415.33	µm
9	2 Points	1412.96	µm
10	2 Points	1411.17	µm
	Average (mean)	1413.83	
	Standard Deviation (σ)	1.77	
	% Relative Standard Deviation (%RSD)	0.13	
11	2 Points	1796.65	µm
12	2 Points	1799.05	µm
13	2 Points	1796.65	µm
14	2 Points	1797.25	µm
15	2 Points	1799.65	µm
16	2 Points	1802.05	µm
17	2 Points	1799.65	µm
18	2 Points	1794.85	µm
19	2 Points	1796.95	µm
20	2 Points	1799.08	µm
	Average (mean)	1798.18	
	Standard Deviation (σ)	2.08	
	% Relative Standard Deviation (%RSD)	0.12	
21	2 Points	1707.99	µm
22	2 Points	1718.55	µm
23	2 Points	1711.28	µm
24	2 Points	1711.28	µm
25	2 Points	1714.54	µm
26	2 Points	1710.57	µm
27	2 Points	1716.41	µm
28	2 Points	1712.39	µm
29	2 Points	1708.76	µm
30	2 Points	1703.05	µm
	Average (mean)	1711.48	
	Standard Deviation (σ)	4.42	
	% Relative Standard Deviation (%RSD)	0.26	

During treatment

Title	Measurement Result		
Date saved	5/16/2017	5:08 PM	
No.	Measure	Result	Unit
1	2 Points	1428.28	µm
2	2 Points	1426.01	µm
3	2 Points	1430.39	µm
4	2 Points	1432.22	µm
5	2 Points	1429.96	µm
6	2 Points	1428.28	µm
7	2 Points	1432.66	µm
8	2 Points	1432.81	µm
9	2 Points	1432.66	µm
10	2 Points	1432.51	µm
	Average (mean)	1430.58	
	Standard Deviation (σ)	2.40	
	% Relative Standard Deviation (%RSD)	0.17	
11	2 Points	1874.79	µm
12	2 Points	1874.37	µm
13	2 Points	1872.29	µm
14	2 Points	1871.44	µm
15	2 Points	1874.79	µm
16	2 Points	1877.73	µm
17	2 Points	1874.79	µm
18	2 Points	1873.14	µm
19	2 Points	1874.79	µm
20	2 Points	1873.95	µm
	Average (mean)	1874.21	
	Standard Deviation (σ)	1.71	
	% Relative Standard Deviation (%RSD)	0.09	
21	2 Points	1797.37	µm
22	2 Points	1799.6	µm
23	2 Points	1798.92	µm
24	2 Points	1798.25	µm
25	2 Points	1794.65	µm
26	2 Points	1797.58	µm
27	2 Points	1792.85	µm
28	2 Points	1794.65	µm
29	2 Points	1792.85	µm
30	2 Points	1794.65	µm
	Average (mean)	1796.14	
	Standard Deviation (σ)	2.50	
	% Relative Standard Deviation (%RSD)	0.14	

After treatment

Title	Measurement Result			
Date saved	5/18/2017	4:51 PM		
No.	Measure	Result	Unit	% Change
1	2 Points	1401.79	µm	
2	2 Points	1399.67	µm	
3	2 Points	1401.74	µm	
4	2 Points	1401.79	µm	
5	2 Points	1401.79	µm	
6	2 Points	1399.67	µm	
7	2 Points	1399.72	µm	
8	2 Points	1397.5	µm	
9	2 Points	1397.5	µm	
10	2 Points	1399.58	µm	
	Average (mean)	1400.08		-0.97
	Standard Deviation (σ)	1.69		
	% Relative Standard Deviation (%RSD)	0.12		
11	2 Points	1856.54	µm	
12	2 Points	1858.65	µm	
13	2 Points	1858.65	µm	
14	2 Points	1858.37	µm	
15	2 Points	1856.27	µm	
16	2 Points	1858.92	µm	
17	2 Points	1858.92	µm	
18	2 Points	1858.1	µm	
19	2 Points	1858.37	µm	
20	2 Points	1858.37	µm	
	Average (mean)	1858.12		3.33
	Standard Deviation (σ)	0.94		
	% Relative Standard Deviation (%RSD)	0.05		
21	2 Points	1779.43	µm	
22	2 Points	1782.33	µm	
23	2 Points	1779.7	µm	
24	2 Points	1779.7	µm	
25	2 Points	1776.8	µm	
26	2 Points	1786.28	µm	
27	2 Points	1783.38	µm	
28	2 Points	1784.17	µm	
29	2 Points	1784.17	µm	
30	2 Points	1781.54	µm	
	Average (mean)	1781.75		4.11
	Standard Deviation (σ)	2.86		
	% Relative Standard Deviation (%RSD)	0.16		
	Average % change			2.16

Bibliography

Abe, Keiko. 2009. “Assessment of the Environmental Conditions in a Museum Storehouse by Use of a Fungal Index.” *International Biodeterioration & Biodegradation* 64: 32–40. doi:10.1016/j.ibiod.2009.10.004.

Adovasio, J. M. 1977. *Basketry Technology: A Guide to Identification and Analysis*.

Anderson, Kat. 2005. *Tending the Wild : Native American Knowledge and the Management of California’s Natural Resources*. Berkeley: University of California Press.

Appelbaum, Barbara. 1987. “Criteria for Treatment : Reversibility.” *Journal of American Institute for Conservation* 26 (2). Taylor & Francis, Ltd.The American Institute for Conservation of Historic & Artistic Works: 65–73. doi:10.2307/3179456.

Baker, Wendy A, and David W Grattan. 2011. “Dimensional Changes of Wood Immersed in Different Consolidant Agents.” In *Proceedings of Symposium 2011 - Adhesives and Consolidants for Conservaiton Research and Applicaitons*, 1–15.

Banik, Gerhard., Irene. Brückle, and Vincent. Daniels. 2011. *Paper and Water : A Guide for Conservators*. 1st ed. Amsterdam: Butterworth-Heinemann.

Bates, Craig D., and Martha J. Lee. 1990. *Tradition and Innovation : A Basket History of the Indians of the Yosemite-Mono Lake Area*. Yosemite Association.

Blanchette, R A, L Otjen, M J Effland, and W E Eslyn. 1985. “Changes in Structural and Chemical Components of Wood Delignified by Fungi.” *Wood Science and Technology* 46: 35–46.

Boyce, Elizabeth. 2012. “Candied Cedar Bark: The Treatment of Waterlogged Western Red Cedar Bark Using Sucrose.” ANAGPIC Student Papers.

Buck, R. D. 1952. “A Note on the Effect of Age on the Hygroscopic Behaviour of Wood.” *Studies in Conservation* 1 (1). Taylor & Francis, Ltd.International Institute for Conservation of Historic and Artistic Works: 39–44. doi:10.2307/1504944.

Cacciari, I., D. Ciofini, M. Mascalchi, A. Mencaglia, and S. Siano. 2012. “Novel Approach to the Microscopic Inspection during Laser Cleaning Treatments of Artworks.” *Analytical and Bioanalytical Chemistry* 402 (4). Springer-Verlag: 1585–91. doi:10.1007/s00216-011-5292-9.

Caneva, Giulia., M. P. Nugari, and O. Salvadori. 2008. *Plant Biology for Cultural Heritage : Biodeterioration and Conservation*. [English e. Los Angeles: Getty Conservation Institute.

CCI Objects Conservation Lab. 2017. “Care of Basketry - Canadian Conservation Institute (CCI) Notes 6/2 - Canada.ca.” *2010*. Accessed November 12. https://www.canada.ca/en/conservation-institute/services/conservation-preservation-publications/canadian-conservation-institute-notes/care-basketry.html.

Crawford, Virginia. 1986. “Artistic Basketry of the North American Indian.” *The Bulletin of the Cleveland Museum of Art* 73 (7): 278–97.

Erhardt, David, Marion F. Mecklenburg, Charles S. Tumosa, and Tone M. Olstad. 1996. “New versus Old Wood: Differences and Similarities in Physical, Mechanical, and Chemical Properties.” James & James (Science Publishers) Ltd., 903–10.

Florian, Mary-Lou E. 1977. “Plant Materials Used in Some Ethnological Artifacts, Structure, Fabrication and Deterioration Related to Conservation Treatment.” In *Preprints of Papers Presented at the Fifth Annual Meeting of the American Institute for the Conservation of Historic and Artistic Works, Boston, Mass., 30 May 2 June 1977*, 51–55. Washington D.C.: The American Institute for Conservation of Historic and Artistic Works.

Florian, Mary-Lou, Dale Paul Kronkright, and Ruth E. Norton. 1990. *The Conservation of Artifacts Made from Plant Materials*. *The Conservation of Artifacts Made from Plant Materials*. 3rded. Los Angeles: Getty Conservation Institute. doi:10.1017/CBO9781107415324.004.

Florian, Mary Lou. 1981. “Analyses of Different States of Deterioration of Terrestrial Waterlogged Wood-Conservation Implication of the Analyses. A Review.” In *Com Committee for Conservation. 6th Triennial Meeting*.

Foreman, Louise. 1971. “Preserve and Protect Your American Indian Baskets.” *The Masterkey for Indian Lore and History* 45 (2): 56–63.

Gilberg, Mark R. 1986. “Plasticization and Forming of Misshapen Birch-bark Artifacts Using Solvent Vapours” 31 (4): 177–84.

———. 2017. “Plasticization and Forming of Misshapen Birch-Bark Artifacts Using Solvent Vapours Author (S): Mark R . Gilberg Source : Studies in Conservation , Vol . 31 , No . 4 (Nov ., 1986), Pp . 177-184 Published by : Taylor & Francis , Ltd . on Behalf of the I” 31 (4): 177–84.

Gleeson, Molly, Samantha Springer, Howard Wellman, Christine Del Re, Patricia Griffin, Emily Hamilton, Kari Kipper, and Carolyn Riccardelli. 2008. “Collaborative Work towards the Preservation of Spruce Root Basketry as a Living Tradition.” *AIC Objects Specialty Group Postprints* 15.

Heinze, Thomas. 2015. “Cellulose: Structure and Properties.” *Advances in Polymer Science* 271. Springer, Cham: 1–52. doi:10.1007/12_2015_319.

Kotonski, Verena. 2012. “The Conservation of Nineteenth-Century Leather-Covered Willow Baskets from Franconia/Bavaria.” *Journal of the Institute of Conservation* 35 (1): 77–91. doi:10.1080/19455224.2012.681292.

Kránitz, Katalin, Walter Sonderegger, Claus Thomas Bues, and Peter Niemz. 2016. “Effects of Aging on Wood: A Literature Review.” *Wood Science and Technology* 50 (1): 7–22. doi:10.1007/s00226-015-0766-0.

Kronkright, Dale Paul. 1981. “New Directions in Native American Basketry Conservation.” In *Preprints of Papers Presented at the Ninth Annual Meeting : Philadelphia, Pennsylvania, 27 - 31 May 1981*, 95–108. American Institute for Conservation.

———. 1990. “Deterioration of Artifacts Made from Plant Materials.” In *Deterioration of Artifacts Made from Plant Materials*, edited by Mary-Lou E. Florian, Dale Paul Kronkright, and Ruth E. Norton, 3rded., 139–93. Los Angeles: The Getty Conservation Institute.

Mantanis, G. I., R. A. Young, and R. M. Rowell. 1995. “Swelling of Compressed Cellulose Fiber Webs in Organic Liquids.” *Cellulose* 2 (1). Kluwer Academic Publishers: 1–22. doi:10.1007/BF00812768.

Mantanis, G., and R. A. Young. 1997. “Wetting of Wood.” *Wood Science and Technology* 31 (5). Springer-Verlag: 339–53. doi:10.1007/s002260050041.

Mantanis, G.I., R.a. Young, and R.M. Rowell. 1994. “Swelling of Wood.” *Wood Science and Technology* 28: 480–90. doi:10.1007/BF00192691.

Mantanis, G I, and R A Young. 1997. “Wetting of Wood,” 339–53.

Mantanis, G I, R A Young, and R M Rowell. 1994. “Swelling of Wood Part I. Swelling in Water.” *Wood Sci. Technol* 134: 119–34.

Mantanis, George I, Raymond A Young, and Roger M Rowell. 1994. “Swelling of Wood Part II. Swelling in Organic Liquids.” *Holzforschung* 48 (6): 480–90. doi:10.1515/hfsg.1994.48.6.480.

McCawley, J. C. 1977. “Waterlogged Artifacts: The Challenge to Conservation.” *The Journal of the Canadian Conservation Institute* 2: 17–26.

McDonnell, G, and A D Russell. 1999. “Antiseptics and Disinfectants: Activity, Action, and Resistance.” *Clinical Microbiology Reviews* 12 (1). American Society for Microbiology (ASM): 147–79.

Meier, Pille, Urve Kallavus, Anti Rohumaa, and Tiit Kaps. 2006. "Multiple Swelling of Pinewood (Pinus Sylvestris) in Binary and Ternary Mixtures of Ethanol, Acetone and Water." *Material Science (Medžiagotyra)* 12 (1): 25–30.

Meier, Pille, Tiit Kaps, and Urve Kallavus. 2005. "Swelling of Pinewood (Pinus Sylvestris) in Binary Aqueous Solutions of Organic Substances." *Material Science (Medžiagotyra)* 11 (2): 140–45.

Nilsson, Thomas, and Roger Rowell. 2012. "Historical Wood – Structure and Properties." *Journal of Cultural Heritage* 13 (3): S5–9. doi:10.1016/j.culher.2012.03.016.

Norton, Ruth E. 1990. "The Conservation of Artifacts Made from Plant Materials." In *The Conservation of Artifacts Made from Plant Materials*, edited by Mary-Lou E. Florian, Dale Paul Kronkright, and Ruth E. Norton, 3rded., 195–286. Los Angeles: The Getty Conservation Institute. doi:10.1017/CBO9781107415324.004.

Odegaard, Nancy. 1999. "Basketry: An Introduction to Materials, Techniques and Conservation." *American Indian Art Magazine*, 37–43.

Ogden, Sherelyn. 2004. *Caring for American Indian Objects : A Practical and Cultural Guide*. Minnesota Historical Society Press.

Padfield, Tim, Janne Winsløw, W B Pedersen, and Jens Glastrup. 1990. "Decomposition of Polyethylene Glycol (Peg) on Heating." *ICOM-CC (International Council of Museums - Conservation Committee) Conference*, 243–45.

Pearlstein, Ellen, Christian De Brer, Molly Gleeson, Allison Lewis, Steven Pickman, Özge Gençay-Üstün, and Liz Werden. 2008. "An Examination of Plant Elements Used for Cahuilla Baskets from Southern California." *Journal of the American Institute for Conservation*. Taylor & Francis, Ltd.The American Institute for Conservation of Historic & Artistic Works. doi:10.2307/27784642.

Salick, Jan, Katie Konchar, Mark Nesbitt, Kew Royal Botanic Gardens, Missouri Botanical Garden, and Mo.) Biocultural Collections : Establishing Curation Standards (Workshop) (2011 : Saint Louis. 2014. *Curating Biocultural Collections : A Handbook*.

Salmén, Lennart, and Anne Mari Olsson. 2016. "Physical Properties of Cellulosic Materials Related to Moisture Changes." *Wood Science and Technology* 50 (1). Springer Berlin Heidelberg: 81–89. doi:10.1007/s00226-015-0777-x.

Schaffer, Erika. 1976. "The Preservation and Restoration of Canadian Ethnographic Basketry." *Studies in Conservation* 21 (3). Taylor & Francis, Ltd.International Institute for Conservation of Historic and Artistic Works: 129. doi:10.2307/1505695.

Schniewind, Arno. 1983. “Mechanical Properties of Wood.” In *Wood in Art Conservation a Seminar on Wood for Practicing Art Conservators*.

Senge, Dana K., and Ellen Carrlee. 2010. “Archaeological Basketry Treatments | Ellen Carrlee Conservation.” *May 2010*. https://ellencarrlee.wordpress.com/2010/05/13/archaeological-basketry-treatments/.

Sequeira, Silvia O., Alan J. L. Phillips, Eurico J. Cabrita, and Maria F. Macedo. 2017. “Ethanol as an Antifungal Treatment for Paper: Short-Term and Long-Term Effects.” *Studies in Conservation* 62 (July). Routledge: 1–10. doi:10.1080/00393630.2015.1137428.

Smith, C. Wayne. 2003. *Archaeological Conservation Using Polymers : Practical Applications for Organic Artifact Stabilization*. Texas A & M University Press.

Smith, Nicola, and Kylie Roth. 2002. “Real-Time Monitoring of Dimensional Change in Australian Aboriginal Bark Paintings during Storage.” In *13th Triennial Meeting, Rio de Janeiro, 22-27 September 2002: Preprints*, 696–700.

Unger, Achim., Arno P. Schniewind, and Wibke. Unger. 2001. *Conservation of Wood Artifacts : A Handbook*. Springer Berlin Heidelberg.

Ward, G. 2008. “The Grove Encyclopaedia of Materials and Techniques in Art.” Edited by Gerald W. R. Ward.

Wendrich, Willeke. 2008. “Basketry in Ancient Egypt.” In *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, edited by Helaine Selin, 392–94. Dordrecht: Springer Netherlands. doi:10.1007/978-1-4020-4425-0_8470.

———. 2012. *The World According Basketry, an Ethno-Archaeological Interpretation of Basketry Production in Egypt*. Cotsen Institue of Archaeology Press. doi:10.1017/CBO9781107415324.004.

Wendrich, Willeke. 1991. *Who Is Afraid of Basketry : A Guide to Recording Basketry and Cordage for Archaeologists and Ethnographers*. Centre for Non-Western Studies, Leiden University.

Wolfe, Sara J., and Lisa Mibach. 1983. “Ethical Considerations in the Conservation of Native American Sacred Objects.” *Journal of the American Institute for Conservation* 23 (1). Taylor & Francis, Ltd.The American Institute for Conservation of Historic & Artistic Works: 1. doi:10.2307/3179770.

Wright, Robert S., Brian H. Bond, and Zhangjing Chen. 2013. “Steam Bending of Wood; Embellishments to an Ancient Technique.” *BioResources* 8 (4): 4793–96. doi:10.15376/biores.8.4.4793-4796.