Title
Strain Enhancement in Sol-gel PZT Energy Harvesting

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Strain Enhancement in Sol-gel PZT Energy Harvesting Devices

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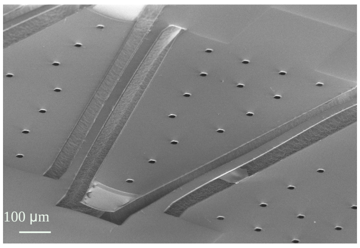
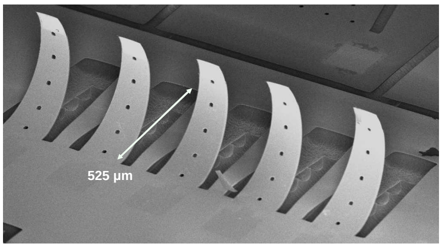
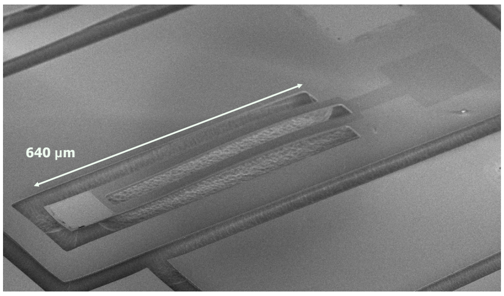
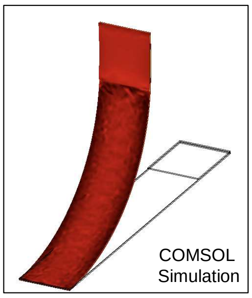


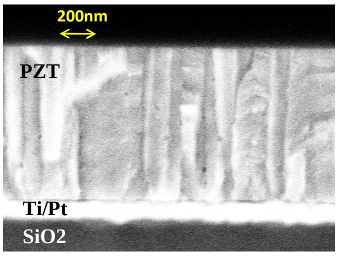


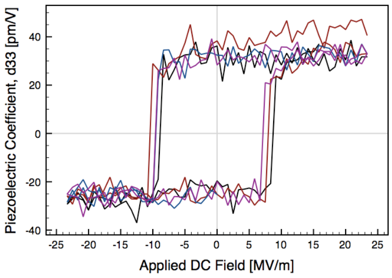




Vision

Ubiquitous wireless sensor networks provide an effective means for monitoring systemic environments with minimal invasiveness. Active monitoring of closed systems by such networks allows for directed, real-time automation, thereby improving system efficiency. Realization of these networks for wide-spread market use requires the sensor nodes be low-cost and require minimal maintenance. Local, renewable power supplies for each node, which convert ambient mechanical vibrations into electricity, are a critical technology for these networks. Our microscale energy scavenging devices are rapidly approaching sufficient generated power outputs through piezoelectric strain-to-charge conversion and clever design. These scavengers can power future nodes.





Methods

☐ On Si substrates, deposit structural and bottom electrode layers with appropriately tailored stress.
☐ Grow sol-gel PZT film by spin-coating.
☐ Characterize PZT with XRD, polarization, & d_{33} measurements.
☐ Use 4-mask microfabrication process to create released, cantilevered structures.
☐ Select geometries that increase strained area.
☐ Model mechanical response of cantilevers.

Next Steps

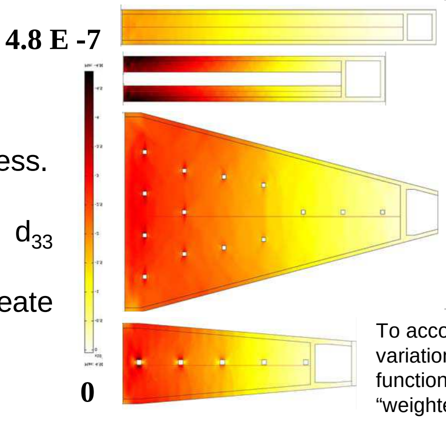
☐ Eliminate residual stress in cantilevers.
☐ Test for power output.
☐ Verify simulations experimentally.
☐ Explore novel scavenger designs, including non-planar designs and multi-resonant designs.

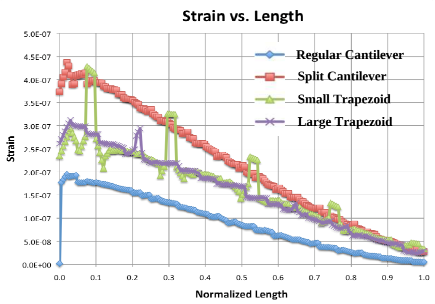
Research Questions

☐ Can sol-gel PZT films achieve desirable piezoelectric properties and morphology?
☐ Can released cantilevers be made from sol-gel PZT?
☐ Will power output increase by changing geometry?
☐ What is the optimized design for a microscale vibrational energy scavenger device?

Findings

$\int \varepsilon(l)w(l)dl$





To account for shape, we weigh the variations of cantilever width as a function of its length *w(l)* into a "weighted strain" *ε'*:

$$\varepsilon' = \frac{\int \varepsilon(l)w(l)dl}{\int w(l)dl}$$

Cantilever Geometry	Resonance Frequency [Hz]	ε', Weighted Strain [10^{-7}]
Rectangular	2588	0.9
Split	3747	2.2
Large Trapezoid	3506	1.8
Small Trapezoid	7233	1.7