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Resolution of absorbing spheres in a highly scattering medium: frequency-domain studies and a tomographic reconstruction scheme.

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Abstract

We performed frequency-domain studies of the diffraction of a photon density wave, traveling in a homogeneous, highly scattering medium, by spherical and disk shaped absorbing objects. Measurements were made with light intensity modulation frequencies in the 10 to 120 MHz range. The source was a diode laser emitting at 810 nm. Skim milk was used as the scattering medium. The effect of the object's size, position, and shape were studied in the transillumination geometry. Spheres as small as 0.8 mm radius were detected with a source-detector separation of 5 cm. A collection of small absorbing spheres was also studied. The spatial characteristics of the bundle of photon migration paths were mapped, in the frequency domain, from source to detector on the surface of the scattering medium (backscattering geometry). The results lead to a model for tomographic reconstruction of objects deep in a scattering medium, made from measurements taken at the surface. This model involves constructing a 3-dimensional density histogram, based on a model bundle and measurements of amplitude, phase, and modulation made at the surface. Supported by National Institutes of Health (RR03155) and UIUC.