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Magnetomotive optical coherence tomography for elastography of small biosamples

AMY OLDENBURG, University of North Carolina at Chapel Hill

Optical coherence tomography (OCT) is a 3D micron-resolution imaging modality using the low-coherence properties of near-infrared light to render depth-resolved images typically a few millimeters into biological tissue. Visco-elasticity is an important parameter for detecting and staging various human diseases. We report a method for analyzing the visco-elastic properties of small tissue samples using magnetomotive OCT. Superparamagnetic nanoparticles (MNPs, ∼20nm) are diffused into a tissue sample. Subsequently, an electromagnet is modulated with a chirped frequency waveform from 0-1kHz, providing a modulated force on the MNPs in the tissue. The mechanical response of the tissue is recorded using OCT at linerates of 1-10kHz. Because OCT is a coherence imaging technique, sub-wavelength displacements are detected in the phase of the interferogram. The mechanical frequency response and associated phase lag fit a model for a damped harmonic oscillator, and results in homogeneous agarose cylinders can be interpreted in terms of Love's solutions for longitudinal vibration modes. A rat mammary tumor biopsy was also analyzed with this technique during formaldehyde fixation, and a trend toward higher frequency correlates with stiffening of the tissue during the fixation process. In collaboration with Stephen Boppart, University of Illinois at Urbana-Champaign.