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Measurement of dynamic shear modulus in soft solids using laser vibrometry

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Shear modulus is an important property of biological tissue and can be imaged for diagnostic purposes. A related application involves the acquisition of precise shear modulus measurements in excised soft tissue. Because the mechanical properties of tissue are frequency-dependent, it is important to develop methods that characterize the elasticity of soft solids at various frequencies. Here, two methods of measuring shear modulus are presented that employ laser vibrometry. At low frequencies (1-10 Hz), the tissue sample is fixed between plates so that the displacement of one plate induces a shear strain. Vibrometer measurements of the plate displacement define the induced strain so that shear modulus can be deduced if the applied shear force is known. At higher frequencies (0.1-10 kHz), the sample lays flat on a surface and an impulsive force is applied to the exposed surface. Using the vibrometer to measure displacements along the exposed surface enables estimation of the surface wave speed and the implied shear modulus. To demonstrate the capabilities of these techniques, experiments were performed using plastisol tissue phantom samples. These experiments indicated a shear modulus that was 50% greater at high frequencies (300 Hz) than at low frequencies (10 Hz). Work supported by RFBR.