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Vibration Potential Imaging: Results for the Forward Problem

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A colloid is a suspension of charged particles in a liquid, with each particle surrounded by a counter charge. When ultrasound propagates through a colloid where the particles have either a higher or lower density than that of the surrounding fluid, the amplitude and phase of the particle motion, owing to the difference in inertia between the particle and the volume of fluid it displaces, differs from that of the fluid so that the particle and the fluid execute different motions. Since the counter charge is carried by the fluid, the oscillatory motion of the fluid relative to the particle distorts the normally spherical counter charge distribution in the fluid creating an oscillating dipole at the site of each particle. The addition of the polarization created at the sites of the particles over a macroscopic length results in a voltage that can be recorded by a pair of electrodes placed in the solution. The ultrasonic vibration potential can be used as a method of imaging where contrast in the image is governed by the presence of colloidal or ionic regions within the body under consideration. We describe the use of a frequency domain method of imaging where the current in a pair of electrodes is recorded as a function of the frequency of a plane ultrasonic wave. The method is applied to imaging a variety of objects including a thin layer, a thick layer, pairs of layers, layers with differing colloidal concentrations and spheres. The experimental results show agreement with the theory of vibration potential imaging that gives the recorded signal as proportional to the integral of the concentration of colloid over the pressure gradient in the ultrasonic wave.