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Deformation of fluid free surfaces driven by high frequency vibration MING TAN, JAMES FRIEND, Monash University, OMAR MATAR, Imperial College London, LESLIE YEO, Monash University — Formation of surface waves on a free surface of a thin fluid layer driven by high frequency (f $\approx$ 20 MHz) surface acoustic waves (SAWs) is investigated, both numerically and experimentally. The SAWs are transmitted along a surface of a piezoelectric substrate vibrating at nanometer displacement amplitudes ξ. Through a perturbation expansion, the governing equations of fluid motion are decomposed into those describing a first-order acoustic field and second-order acoustic streaming. Numerical solution of these equations and use of Fourier transforms allow the fundamental and harmonic frequencies of the surface deformation to be identified. For low excitation amplitudes ($\xi \sim 1$ nm), the frequency of the perturbed free surface is approximately equal to the SAW excitation frequency. However, as the amplitude increases ($\xi > 1$ nm), the dominant resonant frequency of the fluid free surface shifts to the low frequency range (f $\sim$ 1 MHz), suggesting that, in this regime, the free surface deformation is controlled by acoustic streaming. The numerical results for $\xi \sim 1$ nm qualitatively agree with experimental laser Doppler Vibrometry measurements.

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