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Electroosmotic flow in small-scale channels induced by surface-acoustic waves. MATHIAS DIETZEL, STEFFEN HARDT, Institute for Nano- and Microfluidics, TU Darmstadt — Apart from acoustic streaming as the primary effect, surface-acoustic waves (SAWs) go along with time-periodic changes of the electrostatic potential at a solid-liquid interface. This surface potential polarizes the liquid in its vicinity, i.e. it induces a dynamic Debye layer. Alternating current electroosmosis (ACEO) relies on a similar principle. We study the flow field due to the interaction of the dynamic Debye layer with the electric field of the SAW. For this purpose, we consider parallel-plates channels less than 500 nm wide, characterized by an inverse RC time of the Debye layer similar to the characteristic SAW frequencies in the MHz range. By means of numerical simulations of the unsteady Stokes, Poisson, and Nernst-Planck equations, parametric studies are conducted, varying the SAW frequency and amplitude, ionic strength, Debye parameter, as well as the phase shift between two SAWs traveling along opposite channel walls. We demonstrate that for typical SAW amplitudes sizable (time-averaged) net velocities up to 1 mm/s can be obtained, especially if the phase shift equals 180 deg to maximize the periodic electric current between the walls. This significantly exceeds the velocities induced by acoustic streaming in narrow channels.

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