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Research Article

Characterizing Vibrating Cantilevers for Liquid Viscosity and Density Sensing

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Abstract

Miniaturized liquid sensors are essential devices in online process or condition monitoring. In case of viscosity and density sensing, microacoustic sensors such as quartz crystal resonators or SAW devices have proved particularly useful. However, these devices basically measure a thin-film viscosity, which is often not comparable to the macroscopic parameters probed by conventional viscometers. Miniaturized cantilever-based devices are interesting alternatives for such applications, but here the interaction between the liquid and the oscillating beam is more involved. In our contribution, we describe a measurement setup, which allows the investigation of this interaction for different beam cross-sections. We present an analytical model based on an approximation of the immersed cantilever as an oscillating sphere comprising the effective mass and the intrinsic damping of the cantilever and additional mass and damping due to the liquid loading. The model parameters are obtained from measurements with well-known sample liquids by a curve fitting procedure. Finally, we present the measurement of viscosity and density of an unknown sample liquid, demonstrating the feasibility of the model.