Array based real-time measurement of fluid viscosities and mass-densities to monitor biological filament formation

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Liquid mass density and viscosity are fundamental characteristics of fluids. Their quantification by means of classical viscosity and density meters has several drawbacks: (i) the liquid-density and the viscosity cannot be measured simultaneously, (ii) sample volumes in the mL-range are consumed, (iii) the measurements cannot be multiplexed, and, (iv) the quantifications are time-consuming (minutes). Nanomechanical transducers promise to overcome these limitations. We use fully clamped, gold coated silicon-nitride membranes with a thickness of 200 nm to measure liquid viscosity and density of samples of 1 L volumes residing above the membrane in a miniature well. Photo-thermal actuation is used to excite the membrane, and an optical deflection system measures the response. From the response spectra, the eigenfrequency (f) and the quality (Q) factor are extracted and used to determine liquid density and viscosity by applying a three-point calibrated, simplified lumped model. We tested the system using calibrated solutions with viscosities in the range of 1-219 mPa s and mass densities between 998 kg m(-3) and 1235 kg m(-3). Real-time measurements were performed that characterize the polymerization of G-actin to F-actin filaments. The method presented promises to overcome the aforementioned limitations and thereby enables the real-time characterization of sub-L sample volumes in a multiplexed manner.
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