SURFACE TENSIONS OF PICOLITER DROPLETS WITH SUB-MILLISECOND SURFACE AGE

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Aerosols are key components of the atmosphere and play important roles in many industrial processes. Because aerosol particles have high surface-to-volume ratios, their surface properties are especially important to their reactivity and cloud droplet forming potential. However, direct measurement of the surface properties of aerosol particles is challenging. In this work, we describe a new approach to measure the surface tension of picoliter volume droplets with surface age <1 ms by resolving their dynamic oscillations in shape immediately after ejection from a microdroplet dispenser (Figure 1). Droplet shape oscillations are monitored by highly time resolved (500 ns) stroboscopic imaging (Figure 1b). These shape oscillations follow a damped oscillator (Figure 1c), the frequency of which (Figure 1d) gives the surface tension. Droplet surface tension is accurately retrieved across a wide range of droplet sizes (10-25 µm radius) and surface ages (down to ~100 µs). The approach is validated for droplets containing sodium chloride, glutaric acid, and water. Experimental results from the microdroplet dispenser approach are compared to complementary measurements of the surface tension of 5-10 µm radius droplets with aged surfaces using a holographic optical tweezers approach and predictions of surface tension using a statistical thermodynamic model. These approaches combined allow investigation of droplet surface tension across a wide range of droplet sizes, compositions, and surface ages.

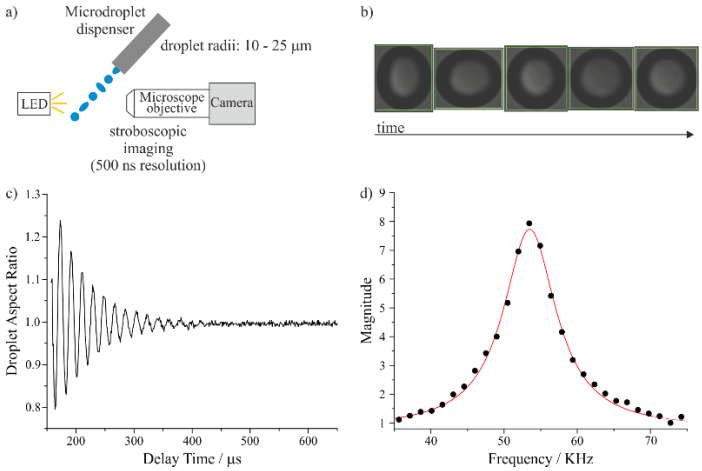

Figure 1. a) Schematic of the microdroplet dispenser setup. b) Images of droplet shape shortly after ejection. c) Droplet aspect ratio vs. time after droplet formation illustrates the damped oscillations in shape. d) A Fast Fourier Transform of the aspect ratio plot gives the oscillation frequency, which allows accurate retrieval of surface tension.

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