Viscosity and dynamic surface tension measurement: A guideline for appropriate measurement

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Dynamic surface tension (DST) measurements are central to understanding interfacial processes in liquids of widely differing viscosities, from low-viscous inkjet formulations to highly viscous coatings and resin systems. Although surface tension itself is independent of viscosity, the *measured* DST at young surface ages can be strongly distorted by the transient flow required for a newly created interface to relax to its equilibrium shape. This relaxation process sets a fundamental lower limit to the surface age at which DST values can be interpreted reliably. At younger times, apparent time-dependent behavior may be mistaken for surfactant kinetics even though it is purely driven by viscous or inertial effects.
In our recent study published in the *Journal of Colloid and Interface Science* (2026), we systematically quantified this minimum reliable surface age across three widely used DST techniques—pendant drop, Wilhelmy plate, and bubble pressure—spanning viscosities from water-like to highly viscous silicone standards. By using pure, surfactant-free liquids, we isolated viscosity-induced hydrodynamic artifacts and identified the characteristic time beyond which each method yields viscosity-independent values. The comparison reveals that each technique has a distinct operational regime: bubble pressure enables the youngest accessible surface ages for low-viscosity liquids, pendant drop becomes the most suitable for high-viscosity fluids, and Wilhelmy-plate measurements generally require substantially longer relaxation times.
Building on these insights, we present a practical phase-plot guideline that allows researchers to select the appropriate method and the youngest trustworthy surface age for any given viscosity. This ensures that observed DST dynamics truly reflect interfacial or surfactant behavior, rather than hidden viscosity effects. The updated guideline provides a simple and robust framework for scientists and engineers working with complex fluids to avoid misinterpretation and to perform more reliable dynamic surface tension measurements.

Keywords:
Dynamic surface tension (DSFT), Surface tension (SFT), Viscous effect, Equilibrium/relaxation time, Surface age, Hydrodynamic forces

References:

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