Condensed Fluidic Elasticity Mapping Using Resonant Vibro-Impact Nonlinear Dynamics

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This project aims to study the adhesivity of condensed fluids, and a cantilever driven by a 3D-printed damped harmonic mechanism is thus designed. This vibro-impact viscometer allows an adjustable sample location and thus, measures the adhesive force from the surface or from the surface-plus-interior of the condensed fluid for being constructed. By measuring the dynamic motion of the cantilever tip, the designed viscometer can reflect the interactive forces between the condensed fluid and the tip, which can then be used to estimate the viscosity of the fluid. Polyvinyl alcohol (PVA205) with varying concentrations is studied using cantilevers with different dimensions, revealing that longer cantilevers (i.e., lower resonance frequency) yield higher responses against concentration variations with a trade-off to the input range. Particularly, the results show that the longer cantilever beam leads to a bigger phase difference between the waveform of the fixed and free end. Also, the longer the cantilever is, the more energy loss it will have. However, the condensed fluid also has its own spectrum while being impacted by the cantilever, resulting in the variation in the vibrating amplitude and thus oscillation energy. To account for the non-uniform distribution of the condensed fluid, I conducted measurements at different points in the petri dish to map out their properties, revealing that the higher the concentration of the PVA solution is, the more spatial non-uniform the fluid becomes. These findings help understand the properties and behavior of condensed fluids in various contexts.