Generating Sub-Millimeter Size Toroidal Droplets

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Introduction

Generating toroidal droplets which are small enough for studying self assembly, defects' pattern still remains largely a challenge. Smaller also means that it is easier to manipulate, for example: the director patterns of liquid crystal are more easily affected by smaller electric force. Also, having smaller size means that the curvature effects are amplified and this is crucial if we want to study how curvature affects the microscopic self assembly.

Experiment

In order to generate small toroidal droplets, high precision is necessary. The previous rotating stage had many mechanical couplings and that causes a lot of vibration during the stage rotation.

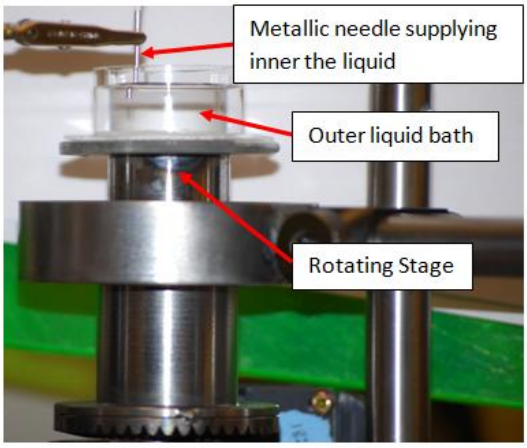

Figure 1: Previous experimental setup.

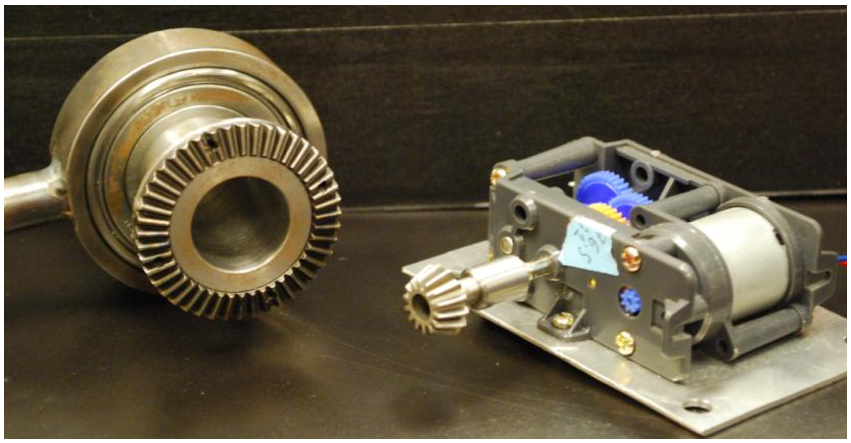

Figure 2: Rotating stage and gear box couple through matching bevel and pinion gear set.

Thus the current rotating stage coupled only with an AC motor which bypassed all of the mechanical coupling and this reduced a lot of vibration.

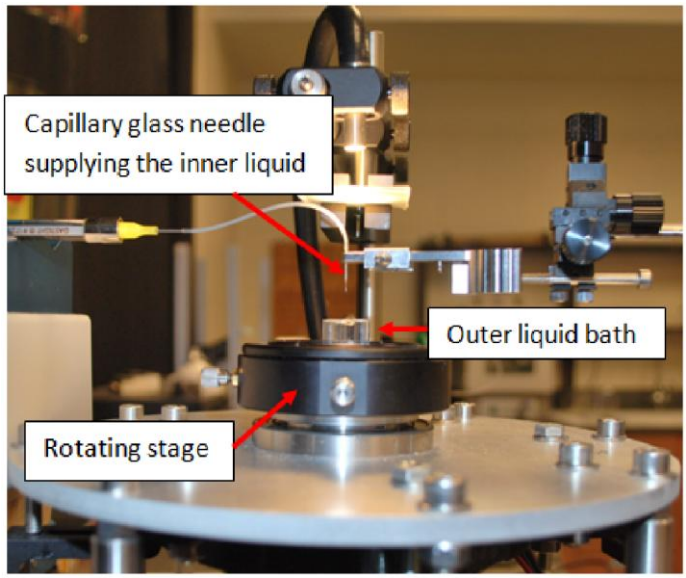

Figure 3: Current experimental setup.

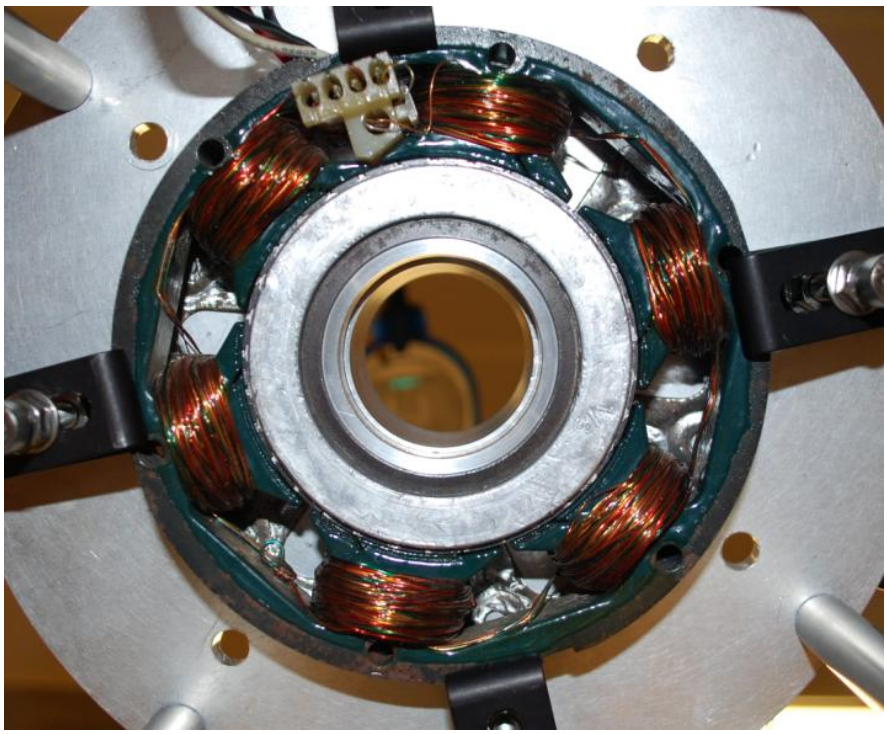

Figure 4: AC motor underneath the rotating stage.

Smoother rotation made it possible to generate much smaller toroidal droplets. Utilizing the same concepts as previous design, the aspect ratio of the torus can be controlled freely.

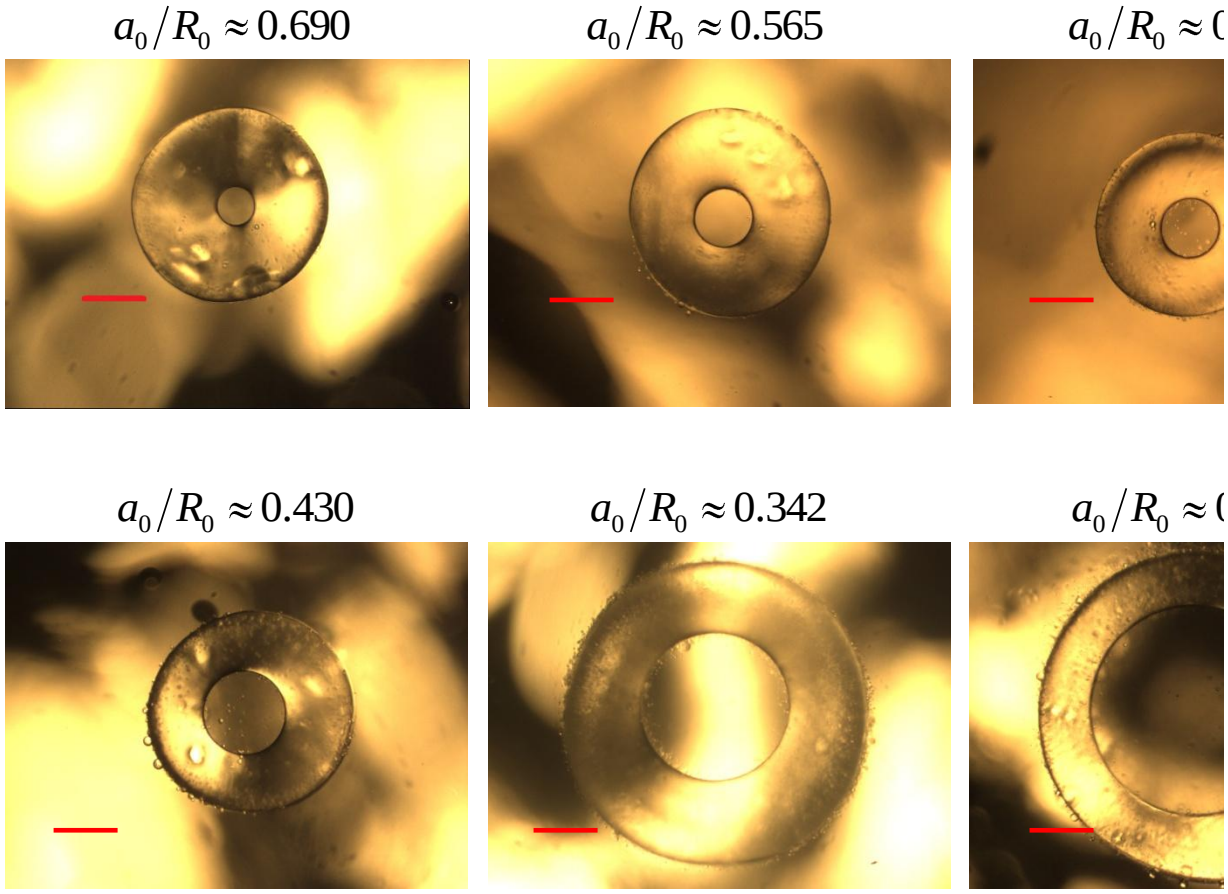

Figure 5: Toroidal droplets made of silicone oil inside viscoelastic medium viewed under a microscope, scale bar is 300µm.

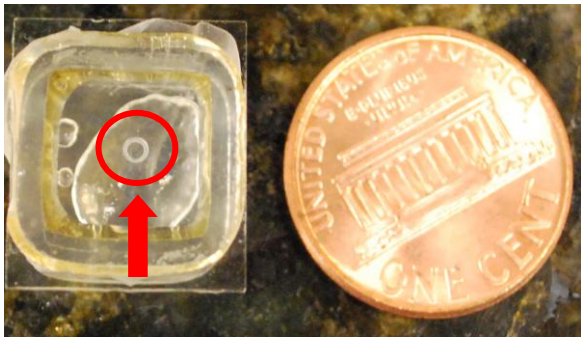

Figure 6: Stable toroidal droplet inside viscoelastic material generated by our new setup compared side by side with a penny.

Useful Reference: E. Pairam and A. Fernández-Nieves, Generation and Stability of Toroidal Droplets in a Viscous Liquid, Physical Review Letters, 102, 234501 (2009).
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