

Contact Line Instabilities in Sliding Viscoelastic Drops

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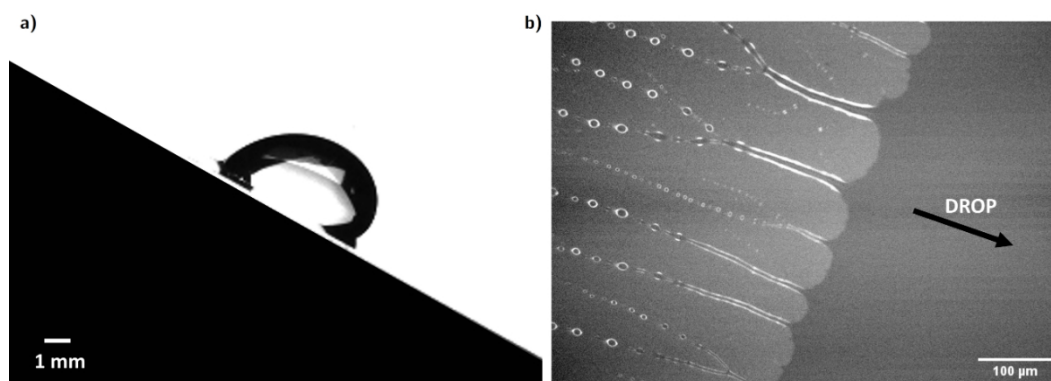
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Controlling the motion of non-Newtonian drops on surfaces is essential for applications ranging from inkjet printing to biomedical devices and food processing. While the macroscopic behavior of viscoelastic drops sliding on tilted hydrophobic surfaces has been characterized—showing reduced velocities [1] and elongation [2] compared to Newtonian fluids—the microscopic mechanisms behind these differences remain poorly understood.

To address this gap, we developed a high-speed, high-resolution reflection microscopy setup that enables direct visualization of the contact line of sliding drops. Using water-soluble polyelectrolyte solutions, we reveal how viscoelasticity influences the dynamics of the receding contact line and, consequently, drop motion. Our experiments demonstrate that viscoelasticity can destabilize the receding contact line, triggering filament formation. This instability previously observed in the coating of thin viscoelastic films [3,4], is reported here for the first time in sliding drops.

We further highlight the critical role of polymer charge in this process: while cationic and non-ionic polymers promote filament formation, anionic polymers do not, a difference that we link to the distinct wetting properties of the solutions. In conclusion, we clarify the interplay between rheology, surface interactions, and drop dynamics.



Viscoelastic drop sliding on a hydrophobic substrate. (a) Side view. (b) Bottom view showing the receding contact line, where instabilities develop and lead to filament formation.

References:

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