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Editorial

Breaking the Symmetry to Reduce Plateau-Rayleigh Instability and Improve Hydropower Efficiency

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EDITORIAL

Natural and commercial processes both require droplet impact on solid surfaces. Controlling the instability after droplet contact, as well as avoiding the creation of satellite drops, has piqued interest due to its importance in inkjet printing, pesticide spraying, and hydroelectric power harvesting. Because of its importance in different fields such as hydroelectric power gathering, inkjet printing, and anti-icing, droplet impact on solid surfaces has been widely explored. The study of droplet instability suppression after striking on diverse surfaces is an important branch. During the droplet impact, there are two types of instability. The Kelvin–Helmholtz instability dominates splashing at the droplet spreading stage, where the thin air layer between the droplet and the solid is compressed, causing splashing at the spreading droplet's edge under specific conditions, resulting in satellite drops. The Plateau–Rayleigh instability in the droplet retraction stage is the other. Under mild perturbations, the retracting liquid at the droplet's periphery collides and forms an upward liquid column, which will become overly elongated and eventually break up into satellite drops.

The Plateau–Rayleigh instability is one of the most well-known droplet retraction phenomenon's, with negative consequences for inkjet printing, pesticide spraying, droplet-based energy collecting, and a variety of other applications. After a droplet collides with a solid surface, great efforts have been undertaken to prevent instability and the creation of satellite drops. For instance, vesicle surfactants were added to water droplets to prevent them from splashing when spraying pesticides and a micro-holes array was constructed on the substrate to minimize Kelvin–Helmholtz instability during droplet hitting. The high retraction velocity of the droplet and the excessive velocity gradient inside the droplet, which extend the liquid column and stimulate the creation of satellite drops, make it difficult to control the Plateau–Rayleigh instability when droplets rebound on solid surfaces. Surface wettability regulation has been shown to be an effective way for accurately managing droplet dynamic behaviours. Droplet directional bouncing and materials transportation, for example, have been achieved by constructing patterned-wettability surfaces where the droplet lateral velocity is found to be related to the surface area of a geometric region, and droplet gyrating and dancing have been achieved by constructing patterned-wettability surfaces where the droplet lateral velocity is found to be related to the surface area of a geometric region. Satellite drops may still occur during these rebounding processes because to Plateau–Rayleigh instability.

The mechanism and principle for precisely controlling the droplet Plateau–Rayleigh instability behaviour are unknown at this time. The symmetry of the droplet impact dynamics can be disturbed utilizing patterned-wettability substrates, which decreases the Plateau–Rayleigh instability during the droplet rebounding phase and enhances hydroelectric energy collection efficiency. The production of satellite drops and the elongation of droplets are used to demonstrate the Plateau–Rayleigh instability. In the meantime, it's inversely proportional to the main droplet rebounding kinetic energy. We discover the mechanism of reducing instability during droplet rebounding from both experimental and theoretical perspectives, namely that the asymmetric superhydrophilic pattern on the superhydrophobic surface regulates liquid flow and minimizes the vertical velocity gradient inside the droplet.

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