Seminar

Institute for Plasma Research

Title : Droplet Motion on Wettability Gradient Surface

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Date : 16th March 2022 (Wednesday)

Time : 11.30 AM

Venue : Online - Join the talk:
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Abstract :

Self-sustained motion of liquid droplets on wettability gradient surface (WGS) is an emerging field due to its vast applications in microfluidics/ biofluidic [1, 2], self-cleaning [3], anti-icing [4], drop based thermal management of electronic device [5, 6], water harvesting via dewing [7, 8] etc. In present research experimental and numerical simulation studies are performed for fabricating linear wettability gradient on the surface and investigating droplet motion along with drop shape evolution on gradient surface. In this context, wettability gradient is fabricated on PTFE surface using plasma-based coating method. Wherein, a one-step, durable hydrophobic-hydrophilic interface is created using a magnetron sputtering deposition technique. The contact angle gradient at the interface increased from 13° to 33°, as the deposition time was increased from 1 to 5 minutes. Although 5 min deposited surface exhibits higher gradient, droplet velocities are higher on 1 min case due to formation of step height at the interface for 5 min deposited surface. Simultaneously, simulations are performed to investigate droplet motion on wettability graded surface, considering Earth's gravity and zero/micro gravity conditions. Present results are useful for designing wettability graded surface specially for condensing surfaces of water harvesting devices for manned space missions. In the numerical simulations 3-D Continuity and Navier-Stokes equations are solved with appropriate boundary and initial conditions using ANSYS FLUENT® for the computational domain. It is observed that droplet motion on the graded surface is attributed to caterpillar like inching motion. Droplets remain almost stationary on superhydrophobic surface (θhigh > 150o) with lower wettability gradient (Δθe = 0.2o and 1o). However, droplet accelerates faster on surface with initial hydrophobic contact angle (θhigh = 100o) and high values of wettability gradient (Δθe = 10o). Although droplet velocity is higher, but droplet spreading is also higher on such surfaces, as compared to superhydrophobic surfaces. Droplet moves even in absence of gravity on wettability graded surface because droplet motion is majorly governed by surface tension force generated due to wettability gradient. However, droplet slightly deaccelerates in microgravity environment. Small size droplet moves faster on the graded surface. Also, effect of gravity is negligible for small droplets. However, drop motion in microgravity is substantially affected for large droplet due to increased value of Bond number.

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