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Modeling the impact, spreading and freezing of a water droplet on horizontal and inclined superhydrophobic cooled surfaces

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Abstract

It is quite important to clearly understand the dynamic and freezing process of water droplets impacting a cold substrate for the prevention of ice accretion. In this study, a three-dimensional model including an extended phase change method was developed on OpenFOAM platform to simulate the impact, spreading and freezing of a water droplet on a cooled solid substrate. Both normal and oblique impact conditions were studied numerically. The evolution of the droplet shape and dynamic characteristics such as area ratio and spread factor were compared between numerical and experimental results. Good agreements were obtained. The effects of Weber number and Ohnersorge number on the oblique impact and freezing process were investigated. A regime map which depicts the different responses of droplets as a function of normal Weber number and Ohnesorge number was obtained. Moreover, the impact, spreading and freezing behavior of water droplets were analyzed in detail from the numerical results.

Keywords:

Numerical modeling; Impact; Freezing; Superhydrophobic cooled surface; Inclined; Water droplet;

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