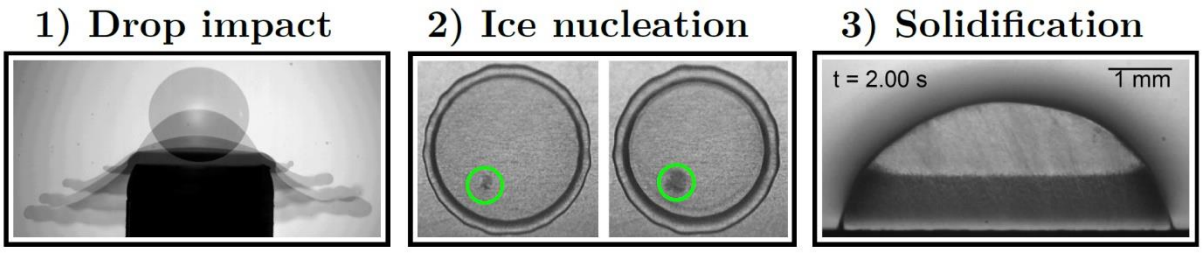
Hydrodynamics and Thermodynamics of Ice Accretion through Impact of Supercooled Large Droplets: Experiments and Modeling

Icing of solid surfaces is an ever-present problem for many engineering applications. In particular ice accretion due to the impact and freezing of supercooled water drops is rich in various physical processes and of relevance for aviation, road traffic, shipping, wind turbines, and high-voltage power lines and insulators. It is initiated by the impact of water drops being in a thermodynamic meta-stable state, followed by nucleation of the impacting drops and ending up with solidification of the liquid, potentially influenced by the impact surface. Following this subdivision, the subprocesses of ice accretion have been separately examined using numerical, experimental and theoretical approaches. Due to its comprehensive nature and the application of new experimental approaches, the present work constitutes a fundamental contribution to a better understanding of the processes taking place during ice accretion by supercooled water drops. It provides theoretical models which allow the prediction of heat transfer during non-isothermal drop impact, the quantitative analysis of experiments aimed at nucleation during drop impact, the prediction of the characteristic solidification velocity for the case of water freezing with wall contact, and the prediction of the residual ice layer thickness after impact of an individual supercooled water drop.



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