Hydrophobic Surfaces: Topography Effects on Wetting by Supercooled Water and Freezing Delay

Hydrophobicity, and in particular superhydrophobicity, has been extensively considered to promote ice-phobicity. Dynamic contact angle measurements above 0 °C have been widely used to evaluate the water repellency. However, it is the wetting properties of supercooled water at subzero temperatures and the derived work of adhesion that are important for applications dealing with icing. In this work we address this issue by determining the temperature-dependent dynamic contact angle of microliter-sized water droplets on a smooth hydrophobic and a superhydrophobic surface with similar surface chemistry. The data highlight how the work of adhesion of water in the temperature interval from about 25 °C to below −10 °C is affected by surface topography. A marked decrease in contact angle on the superhydrophobic surface is observed with decreasing temperature, and we attribute this to condensation below the dew point. In contrast, no significant wetting transition is observed on the smooth hydrophobic surface. The freezing temperature and the freezing delay time were determined for water droplets resting on a range of surfaces with similar chemistry but different topography, including smooth and rough surfaces in either the Wenzel or the Cassie–Baxter state as characterized by water contact angle measurements at room temperature. We find that the water freezing delay time is not significantly affected by the surface topography and discuss this finding within the classical theory of heterogeneous nucleation.

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