Wettability behavior of superhydrophobic silicone rubber coatings at supercooled temperatures

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Power network equipment with icephobic surfaces is always desirable for reducing ice and snow accumulation. So, protecting aluminum ground wires and phase conductors of overhead power lines against ice adhesion, through application of superhydrophobic coatings with icephobic properties on their surfaces seems to be an interesting solution.

Superhydrophobic surfaces can be prepared by the combination of micro-nano structure and low surface energy materials. Anodic aluminum oxide has been proposed as a suitable industrial process to form nano-pore structured films and to improve resistance to corrosion and wear.

In this study, a superhydrophobic surface was obtained via anodization of aluminum substrates in phosphoric acid followed by RTV silicone rubber coating. Study of the surface wetting properties showed a high static contact angle, up to 160 ° for the treated surfaces at room temperature.

Since the wettability behavior at supercooled temperatures is of prime importance for the development of icephobic coatings, the contact angle was analyzed for temperatures ranging from 20 °C to −10 °C. Lower wettability was observed when the surface temperature went down between 20 °C to -10 °C. Indeed, when micro-nano-structured surfaces were exposed to temperatures lower than 0 C, condensed water penetrated into the porosities of the coating and water vapor condensation lead to the Cassie-Wenzel regime transition resulting in lower contact angles.

However, superhydrophobic surfaces at supercooled temperatures showed important delayed freezing time compared to RTV hydrophobic surfaces and aluminum bars.

The electrical capacitance was also measured using an Agilent 4294A impedance analyzer, with frequency ranging from 40 Hz to 2 KHz. This measure revealed that the superhydrophobic surfaces had low capacitance and consequently low dielectric constant.