PO2082

# Micro-/nanostructured anti-ice polymer films by hot embossing and roll-to-roll PECVD coating – Surface characterization and correlation with wetting and icing behavior

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Ice build-up on surfaces of transport vehicles, like airplanes, or technical facilities, like wind energy rotors, can lead to severely reduced efficiency or safety. Functional anti-ice surfaces can possibly reduce the amount of costs, energy and chemicals used in state-of-the-art de-icing methods. Superhydrophobic surfaces were produced on thermoplastic polyurethane (PU) films which were chosen because of their outdoor stability. The PU films were first textured with different microstructures by hot embossing. Afterwards they were coated with a hydrophobic fluorocarbon or silicone-like plasma polymer thin film with a nanometer roughness. The plasma polymer thin films were analyzed by spectroscopic ellipsometry, ESCA and AFM measurements. Swelling tests were made to characterize the chemical network structure and sand trickling tests were done to analyze their mechanical stability. Finally, the so-prepared surfaces were characterized for their wetting and icing behavior. Very high water contact angles (>150°) and roll-off angles below 2° were measured and compared to the theoretical wetting states. For the determination of the icing behavior, water drops were frozen on the surfaces in a freezing test chamber with a constant cooling rate at different relative humidity values. The temperature of the droplets was recorded by an IR-camera. The freezing process was automatically evaluated from the recorded movie. In this way, the nucleation and crystallization temperatures on the different surfaces were measured. On the best anti-ice surfaces a water drop stays liquid until -21 °C temperature. The ice adhesion on microstructured and plasma coated surfaces could be reduced by more than 90% compared to reference materials. The results of the surface characterization were correlated with the wetting and icing test results. The chemical structure analysis results were related to the mechanical stability. The plasma coating process was scaled up to a roll-to-roll process.

**Keywords**
roll-to-roll
micro-/nanostructure
superhydrophobic
anti-ice