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Plasma functionalization of structured surfaces to control the formation of ice

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Currently, the topic “icing” is receiving more and more attention in many industrial areas, such as for the design and operation of aircrafts, wind mills, or electrical networks. For aircrafts, de-icing before take-off is time consuming and expensive. State-of-the-art in-flight heating of the wings by exhaust gases (“bleed air”) consumes up to 30% of the engine power. Moreover, due to the replacement of metal by carbon-fiber reinforced materials as construction material, bleed-air heating will be no more applicable in future.
The aim of this project is to develop structured surface coatings which allow influencing the formation of ice crystals and films, and to analyze and model the interfacial interactions (water–ice–coating). Therefore, surfaces, e.g. polymer foils, will be chemically functionalized and structured in order to control the wetting behavior and the ice-crystal growth. The chemical functionalization will be done by PECVD of thin films of different chemical composition.
For the evaluation of the functionalized surfaces, lab-based test methods will be developed. In order to achieve atmospheric icing conditions and to study the freezing delay/icing behavior on functionalized surfaces, supercooled water droplets are generated in a specially designed cryogenic chamber and wind tunnel. The wind tunnel allows the investigation of icing under real aerodynamic flow with wind speeds up to Mach 0.35.
Simulation methods are going to be applied for a detailed description of the thermodynamic and kinetic aspects of the ice-formation process on functionalized surfaces, taking into account the special environmental conditions that may be encountered during the flight.

Keywords
anti-ice
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