Development of conductive coatings for sustainable active anti-icing systems

Christine Rincke*[1], Ron Luft[2], Rafal Stanik[3], Bartlomiej Przybyszewski[4], Kristin Trommer†[1], Maik Gude[3], and Anna Boczkowska[4]

[1]FILK Freiberg Institute gGmbH – Germany
[2]TUD Dresden University of Technology, Institute of Lightweight Engineering and Polymer Technology – Germany
[3]TUD Dresden University of Technology, Institute of Lightweight Engineering and Polymer Technology – Germany
[4]Warsaw University of Technology [Warsaw] – Poland

Abstract

Ice mitigation is critical across the wind energy, aviation and railway sectors, where ice accretion poses severe economic and operational challenges. Therefore, new function-integrative anti-icing solutions are needed that provide significant added value in terms of resource and energy efficiency while simultaneously increasing functionality. At the same time, the growing demand for efficient solutions requires flexible, cost-effective, and reliable manufacturing technologies.
To address the limitations of conventional de-icing systems, the German-Polish cooperation project ActiCOAT pursued a novel approach based on electrically conductive coatings applied to fiber-reinforced composite structures. The concept employs a flexible manufacturing process in which carbon nanotubes (CNTs) are dispersed in an unsaturated polyester resin and subsequently processed into flexible, electrically conductive heating films by blade coating. These films are then integrated as the outer layer of fiber-reinforced composite components using an automated pressing process, representing a newly developed manufacturing route for actively heated composite structures. In addition to the material and process development, the project included the implementation of sensor and control technologies, the investigation of the interaction between manufacturing parameters and structural properties, and the development of testing methods for evaluating anti-icing performance under a wide range of operating conditions. As a proof of concept, an actively heated aircraft wing demonstrator was successfully manufactured, providing a representative test specimen for realistic investigations in an icing wind tunnel.

The new approach offers several technical and technological advantages, such as the reduction of weight and construction volume through the use of function-integrated materials compared to external and less efficient anti-icing systems.
The project ActiCOAT" (reg.-no. 01IF00381C) was funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK) as part of the Industrial Collective Research (IGF)" program on the basis of a decision of the German Bundestag. We would like to thank for the support.

*Corresponding author: christine.rincke@filkfreiberg.de
†Speaker

Keywords: Anti, Icing solution, Fiber Reinforced composites, heatable composites, blade coating, unsaturated polyester, carbon nano tubes (CNT)