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Surface Degradation of Wind Turbine Blades: Computational Modelling

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Wind turbine blade erosion is now the largest issue of wind energy development, affecting all wind turbine types and offshore operators. Leading edge erosion (LEE) is responsible for more than 5% reduction of annual energy production for a utility-scale wind turbines [1,2]. Leading edge erosion leads to huge maintenance and downtime costs. For example, the power company Ørsted announced in 2016 that all 273 blades at their Horns Rev 2 offshore wind farm, which has been operational for six years, were severely eroded. The way to protect the wind turbines against erosion is the using of advanced polymer coatings. In order to develop the new optimized coatings, computational modelling and numerical testing can support the materials development and testing. In this presentation, the methods of computational modelling of leading edge erosion and the numerical studies of the effect of the coatings on the blade degradation.

In the computational model, the material under droplet was designed as multilayered materials, with two layer protective coating, gelcoat, and filler, all on the top of laminate.

In this way, the model can be used for optimization of protective coatings and their structures, testing various parameters of the protective systems and development of recommendations to their improvement.

The model is used to study various coating structures, and compare two extreme cases, namely, stiff upper coating/soft lower coating and, inversely, soft upper coating/stiff lower coating placed on homogeneous gelcoat, filler and laminate. It was demonstrated that varying the stiffness and amount of protective layers, one can control the damage initiation and growth if composites. Highest stresses are observed for the case of stiff upper coating, while soft upper coating (placed on the top of stiff) keeps the stresses relative low.