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Icephobic Polyethylene/Carbon Coating by Dual Suspension-Powder Flame Spray TechniqueIcephobic Polyethylene/Carbon Coating by Dual Suspension-Powder Flame Spray Technique

Abstract:
Ice formation on solid surfaces can affect operations of aircraft, wind turbines, transmission lines, roads, ships, heat-exchange systems and cause economic losses and safety risks. Coating is one of the best ways to reduce ice adhesion and make ice removal easier. Flame-sprayed polyethylene coatings have improved icephobicity, which allows the ice to be removed more easily by external forces. However, polyethylene has very low thermal conductivity and light absorption, and this can limit its use in active de-icing methods such as heating and light irradiation. Carbon nano-powders cannot be directly used in conventional flame spraying because particle size is very small and the powder has low flowability, which leads to clogging of the spray torch. On the other hand, addition of carbon-based materials to PE can be done to enhance thermal conductivity and light absorption. In this research, polyethylene/carbon black composite coatings were produced by a dual suspension-powder flame spray process. While polyethylene was used as the main coating material in the powder form, carbon black was introduced to the flame as the suspension to enhance the functional properties of the composite coating. The final coating demonstrated low ice adhesion, strong light absorption, and better heat-transfer behavior. These properties helped faster and more efficient ice removal by several de-icing methods, for example mechanical removal, heating, and light irradiation. These results suggest that flame sprayed polyethylene/carbon black composite coatings can operate as multifunctional icephobic coatings for anti-icing and de-icing applications.