Title:

Hybrid superhydrophobic coatings using a green approach

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Abstract

Ice accretion on exposed surfaces poses known safety and performance problems in cold climate. Anti-frost coatings have the potential to solve them in a cost-effective, energy saving manner that is also safe to the environment.
The aim of this study is to develop nanoparticle-polymer coatings with ice repellent properties that are easy to manufacture using eco-friendly and/or renewable materials. The novel formulations contain three components:
1. iron oxide nanoparticles able to mutually interact and assemble to produce surfaces with hierarchical roughness;
2. chitosan as a polymeric matrix;
3. alkoxysilane as a coupling/crosslinking agent.
Iron oxide (Fe_3O_4) nanoparticles with an average size of 14 nm, high phase purity and saturation magnetization (88 emu/g) were prepared by partial oxidation of ferrous ions in alkaline solution and subsequently functionalized with sodium oleate. Hybrid thin films comprising nanoparticles in alcohol suspension, chitosan in aqueous acidic solution and partially hydrolysed hexadecyltrimethoxysilane were produced by spray coating. The films were cured by heating and characterized regarding their morphology (scanning electron microscopy) and contact angle with water. The procedure was optimized regarding formulation composition and structure to yield thin films with nanoparticle induced texture and maximum contact angle.
The optimum formulation demonstrated lot to lot reproducibility and good adherence to various substrates (glass, plastic, metal). SEM micrographs evidenced micro-scale protuberances with nano-scale features that may facilitate air pocket entrapment underneath water drops resting on the surface. The observed morphology is consistent with the superhydrophobic character of the prepared films, as evidenced by the high contact angle (159^0).
Preliminary studies indicate that the novel hybrid materials may be used as ice repellent coatings.

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