CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
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Project Number
S0329

Project Title
Super-hydrophobic Surface for Anti-Icing Applications

Abstract

Objectives/Goals
This experiment was conducted to determine if a super-hydrophobic surface repels ice. I believe that the surfaces with higher contact angles (and thus higher hydrophobicity) repel ice more effectively than the surfaces with lower contact angles.

Methods/Materials
Naturally-occurring super-hydrophobic surfaces provide good models for constructing an artificial copy. An investigation of the surface structure of lotus leaves enabled the design of a bionic super-hydrophobic surface coating made with Teflon micro-particles coated onto metal plates using an adhesive layer. Six super-hydrophobic surfaces were fabricated with different adhesives and the contact angle of each was measured to determine its hydrophobicity. The best hydrophobic surface was identified to have a contact angle of 170° and its practical applications were tested by applying it to the rotor blades of a model helicopter.

Results
It was found that a super-hydrophobic surface with a well-designed surface micro-structure does repel ice. A surface with higher hydrophobicity is more efficient at repelling ice; a surface with a contact angle of less than 140° only has a limited ice-repelling capability, while a surface with a high contact angle (170°) is an effective anti-icing surface. The super-hydrophobic coating was then applied to a rotor blade of a model helicopter. When tested in both on-the-ground and in-flight conditions, the rotor blade with the coating was free from ice while ice accumulated on the control blade without the coating.

Conclusions/Discussion
This project confirmed that a well-designed super-hydrophobic surface does repel ice and that a surface with a higher contact angle is more efficient at repelling ice. The super-hydrophobic surface applied on a model helicopter did prevent ice formation in both on-the-ground and in-flight scenarios. This data suggests that icing problems in many other applications can be prevented using a super-hydrophobic surface coating.

Summary Statement
This project examines the ice-repelling capabilities of super-hydrophobic surfaces made with Teflon micro-particles and different adhesives; it also explores the applications of this ice-repelling surface in preventing icing on helicopters.

Help Received
My parents helped me purchase experimental materials. Dr. Lily Wu (researcher, UCI) trained me with lab safety and use of lab equipment. Mr. Martin Lopez supervised the experiment and supplied lab equipment at Physical Optics Corporation. Mr. Tim Smay (AP Physics teacher, University High) guided