CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

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Project Number

S0612

Project Title

AquaDefense: A Multipurpose Hydrophobic Material Synthesized via the Substitution of Polar Hydroxyl Groups

Abstract

Objectives/Goals

Our objective is to create a hydrophobic material that can exhibit a contact angle that exceeds 90 degrees, hopefully achieving close to or surpassing the Lotus Effect. A parallel objective is to find a practical method of delivering and applying the material onto the surface of a variety of materials including but not limited to metals, cloth and glass surfaces. Additionally, we are investigating the feasibility of mass producing the product, examining aspects such as the economic and environmental factors. We would like to create a product that would be able to withstand a high amount of interaction with oil as current products are not capable of doing so.

Methods/Materials

To produce the foundation for our material, silica gel, we combined 30ml of tetraethylorthosilicate with 31ml of ethanol. We added this solution to a solution of 38ml of distilled water with 4 drops of hydrochloric acid under constant stirring. We heated the solution in a sand bath heated to 60°C for 1.5 hours. Once done, cooled the solution and placed it in a drying oven at 60°C until the remaining liquid has evaporated. We also repeated the process using ammonium hydroxide in place of hydrochloric acid. For make the silica gel hydrophobic, we soaked the gel in a series of hexane and trimethylchlorosilane solutions of gradient concentrations. We used a high resolution digital camera in conjunction with a macro lens to take a highly detailed photo of the contact angle.

Results

We successfully created a powdery material exhibiting an average contact angle of 114 degrees, exceeding all our preliminary experiments using off-the-counter products. A water droplet applied to the surface was immediately and clearly expelled.

Conclusions/Discussion

Through the clear improvement in contact angles, we assume that the exchange of hydroxyl groups was successful. In this study, we managed to make a desiccant gel hydrophobic through the exchange of surface groups on the gel. The transformation is obvious as the gel repels water rather than absorbing the liquid.

Summary Statement

Our project is an attempt of formulating a highly hydrophobic material through the modification of silica gel as well as an exploration of intermolecular behavior in water repellent materials.

Help Received

John Allen acted as our mentor; Kevin Lyter lent camera equipment as well as advice.