

Innovation

STTR Topic Number:
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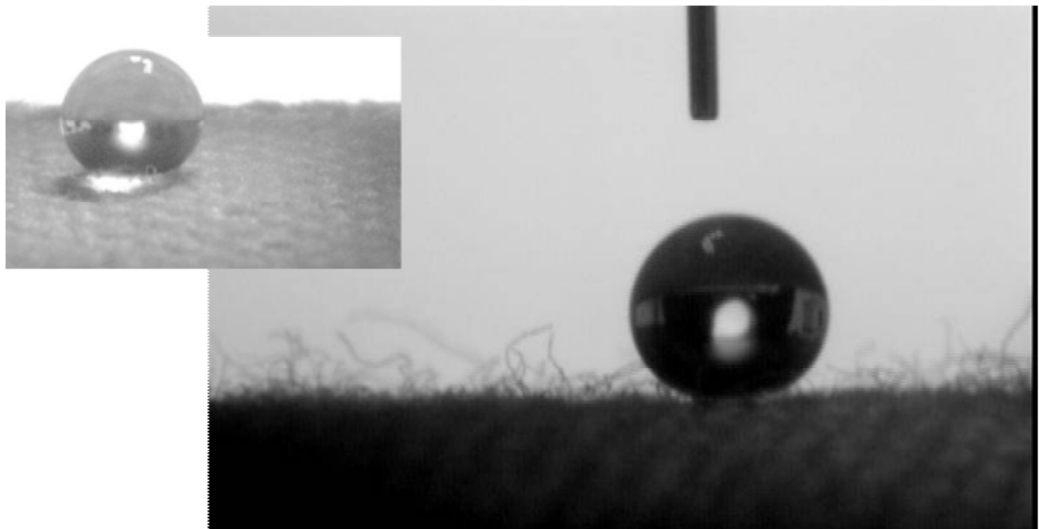
STTR Title:
Ultrahydrophobic
Coatings

Contract Number:
FA9550-06-C-0033

STTR Company Name:
Luna Innovations
Incorporated, Blacksburg,
VA

Technical Project Office:
Air Force Office of
Scientific Research,
Arlington, VA

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.



Water droplets beading up on ultrahydrophobic coated cotton and cotton/polyester blend fabrics

Ultrahydrophobic Coatings

- Application of the water-repelling “Lotus leaf” effect could enhance corrosion protection of aircraft and ground vehicles, chemical and biological defense, and water-proofing for clothing items
- Ultrahydrophobic coatings were produced (1) by incorporating hierarchical particulate additives and (2) using sol-gel chemistries to produce corrosion protective coatings for metal surfaces
- Ultrahydrophobic coatings are simple to apply using conventional, cost-effective techniques; they could reduce maintenance, decrease life cycle costs, and increase readiness by limiting equipment down-time
- Other potential uses include corrosion protection for metal components, anti-graffiti coatings, moisture and stain-resistant fabrics, microelectromechanical systems, and marine biofouling

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Air Force Requirement

The Air Force requires new processes to improve the water resistance of a large variety of materials including aircraft, ground vehicles and clothing. A novel mechanism to generate water-repelling (hydrophobic) materials was recently identified. A Lotus leaf, shown here, utilizes microstructured hydrophobic coatings to produce ultra-



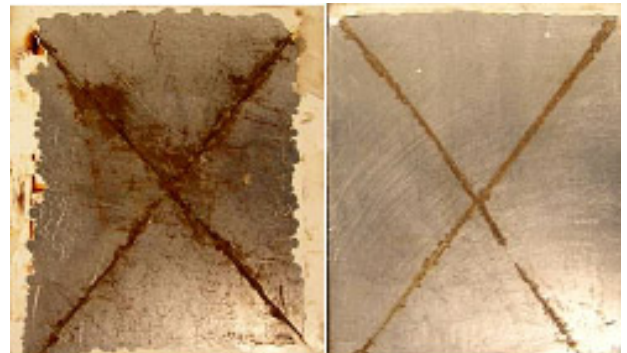
Water droplets beading up on a Lotus leaf

hydrophobic materials that not only repel water but are also self-cleaning to provide protection from dirt and pathogenic organisms. Application of this process could enable the Air Force to enhance corrosion protection of aircraft and ground vehicles as well as provide chemical and biological agent protection and water-proofing for uniforms and other clothing items.

STTR Technology

Under this STTR program, Luna Innovations teamed with the University of New Mexico to develop a biomimetic approach to producing the "Lotus leaf" effect described above. Ultrahydrophobic coatings were developed that are simple to apply using conventional techniques and cost-effective for widespread military and commercial applications. Ultrahydrophobic coatings were produced via two methods. The first incorporated hierarchical particulate additives, i.e. particles possessing a dual micro-nano surface topology. These were synthetically produced via solution and solid phase reaction methods for use as additives in selected solvent-borne and water-borne paint systems. Over 300 different particles were produced with selected primary and secondary sizes to determine the optimum additive to achieve ultrahydrophobic character in the resultant paint system, as shown in the Page 1 illustration of additives applied to cotton and cotton/polyester blend fabrics. The second method used simple sol-gel chemistries to produce a high barrier coating to prevent corrosion causing substances from reacting to metal surfaces. A series of aluminum and low carbon steel panels were coated with ultrahydrophobic paint for accelerated salt fog corrosion testing per ASTM B117. The panels were coated with epoxy primer followed by polyurethane top coats with selected ultrahydrophobic particles having different morphology/surface treatments. Aluminum panels showed no noticeable corrosion after 2000 hours, as compared with significant pitting and delamination for the control coated panels. Likewise, steel panels also had significantly lower corrosion than the control coated

panels after a 500 hour test, shown here after paint removal subsequent to the test.



Control paint

Ultrahydrophobic paint

Potential Air Force Application

Potential Air Force applications of this ultrahydrophobic coating technology include corrosion protection of aircraft and ground vehicles, chemical and biological warfare defense, and water-proofing for clothing items. This technology is synergistic with complementary technologies in high barrier aluminum surface treatments, thus producing an extremely corrosion resistant paint system with the ability to scale to large substrates (such as spray coating for aircraft). Such coatings are simple to apply using conventional techniques that are cost-effective for widespread use in both military and commercial applications. This technology has the potential to decrease life cycle costs, reduce maintenance, and increase readiness by limiting equipment down-time.

Company Impact

The ability to produce water-repelling (hydrophobic) surfaces has a huge potential impact on commercial applications such as corrosion protection for metal components, anti-graffiti coatings, low surface energy microelectromechanical systems (MEMS), and moisture and stain-resistant fabrics. Another promising application is in the area of biofouling--the attachment of undesired biomaterials, such as marine organisms, to a surface. Marine biofouling prevents the attachment of such organisms on ship hulls that results in increased fuel consumption, decreased speed/efficiency, and the potential transport of non-indigenous species.



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