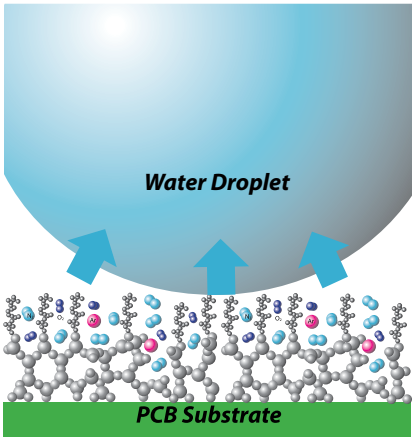
IST Integrated Surface Technologies

Repellix™ Supermolecular Ceramic Coating Description

Integrated Surface Technologies™ (IST) provides Repellix™, a supermolecular ceramic coating for water protection. The novel technology that makes up Repellix is very different from the liquid spray ("conformal") coatings that have been the primary option until now. Departing from this thick spray-coat technology, Repellix is a thin-film, superhydrophobic solution to wetting damage.

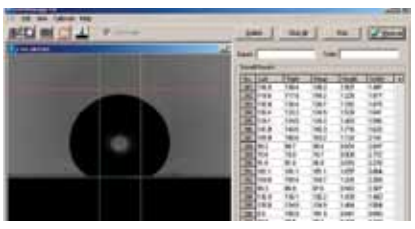
Water Interface Characteristics

Film Structure Creates Water-Repellance



Repellix's ceramic structure can be tuned to the desired density, depth, and hardness. It repels water due to several factors: 1) the geometry of the topography or physical structure, 2) the density of coverage, and 3) the surface energy. The end result is a surface that will noticeably repel water.


Goniometer Water Droplet Dispenser


Goniometer Measurement Sample

The standard way to quantify water repellance is to measure the surface tension, the angle between the solid surface and the tangent to the water droplet surface by using a Goniometer. Angles below 40˚ are considered "hydrophilic", and appear to spread on the surface. "Hydrophobic" refers to angles > 90˚. Repellix from IST regularly produces "super-hydrophobic" angles >150˚.

- **Super-hydrophobic contact angles: > 150°**
- **Contact angle uniformity: +/- 5%**
- **Surface energy: < 3 μJm^{-2}**
- **Water Vapor Transmission Rate (WVTR): <0.02gm/meter^2-day (85% RH, Mocon on PEN 10nm film)**
- **Static submersion time: > 30 minutes**

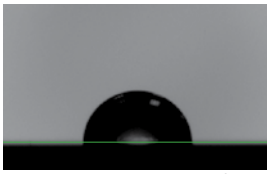
Uncoated board performance


Water on Silicon

Hydro***philic*** is from "water" and "love." Water adheres to the surface.

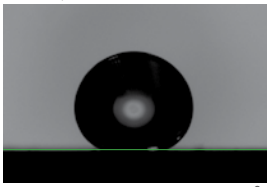

Hydrophilic <40˚

Hydro***phobic*** derives from the latin "water" and "fear". Water is repelled from the surface.


Hydrophobic >90˚

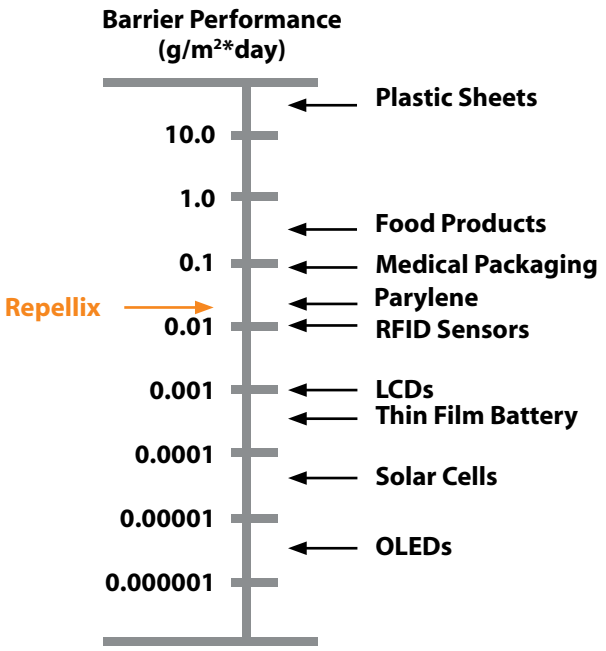
Repellix performance

Superhydrophobic refers to contact angles > 150 degrees.


Super-Hydrophobic >150˚

Water Vapor Transmission Rate (WVTR)

Different materials have different porosities to water. For example, thin plastic food wraps have a transmissivity of 70 grams per square meter per day, whereas a thick sapphire film for OLEDs has a super low transmissivity of 5 millionths of a gram. Despite its semi-porous nature, Repellix has a low transmissivity to water vapor – only 0.02. The corresponding Oxygen transmission rate is <0.05.



Mechanical Properties

Repellix is composed of supermolecular building blocks contained in a flexible latticework. Because it is very thin, it transmits heat extremely well, but has minimal resistance to repeated abrasion. The mechanical properties can be tuned in the specific recipe created for each unique application.

Density: 2.4-2.5 g/cm³

Stress: <0.4 MPa @33˚C

Elastic (Young's) Modulus: 165 GPa

Hardness: 12 GPa (Berkowitz Scale)

Dielectric Strength: 20 MV/cm

Thickness: 30-500 nm

RMS (Roughness): 60-120 nm

Maximum Temperature: 250˚C for 1 hour

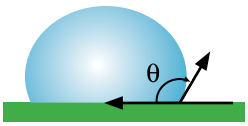
Heat Dissipation: Excellent

Refractive Index: 1.58

Optical Transmission: <2% absorbtion over spectra range 400-2100nm (20nm thick film)

Definition of Terms*

Contact Angle is measured by producing a drop of pure liquid on a solid surface. The angle formed between the solid/liquid interface and the liquid/vapor interface and which has a vertex where the three interfaces meet is referred to as a the contact angle.



Hydrophobicity occurs when a drop forms with a large contact angle, over 100°. In this condition wetting is considered poor and surface energy is low. If the contact angle exceeds 150°, such as water on a lotus leaf, then the material is considered superhydrophobic.

Surface Energy or Surface Free Energy is the excess energy at the surface of a material compared with the material as a whole. There are various methods for measuring surface energy. Young's Equation is one method which can be used to quantify surface energy.

Wettability defines the degree to which a solid will wet. If a drop spreads out indefinitely and the Contact Angle approaches 0°, then total wetting is occurring. In most cases, however, the drop will bead up and only partial wetting (or non-wetting) will occur. The extent to which a solid will wet can be quantified by measuring the Contact Angle.

*Courtesy of Rame'-Hart

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