

The elusive permanently hydrophilic surface

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Very often customers come to us with a simple request; *“Our device needs a permanent hydrophilic surface”*. They are both surprised, disappointed and doubtful when our answer is that it is impossible, and they must engineer around the technical problem they have!

The stability of hydrophilic surfaces is significantly different in three conditions:

1. Stored in a pouch in dry air with a desiccant.
2. Stored in humid air.
3. In contact with liquid water.

In none of these three conditions will a surface remain hydrophilic forever! However, the hydrophilic functional time is very different in the three conditions, ranging from seconds to many years.

Simple surface activations such as oxygen plasma, corona and flame treatment, will decay fast in a process known as hydrophobic recovery. In dry air the hydrophilic surface property will remain for hours to weeks. In humid air it will remain significantly shorter. The hydrophilic surface property is instantly lost when contacting liquid water.

More **advanced hydrophilic coatings and materials** (such as ours) will remain hydrophilic for years in dry air. In humid air it may be years, but this depends on device material and many other conditions. In contact with liquid water the hydrophilic surface decays fast. It can range from seconds to 30 minutes, but it is by no means permanent. Exactly how long time the surface will remain hydrophilic depends on the liquid conditions flow rate, temperature, chemistry, bubbles, ultrasound etc.

Hydrophilic surfaces are roughly split into two groups:

1. Localized reactive groups ready for interaction with water. Once these groups have interacted/bonded with a water molecule, they lose their reactive nature and the surface becomes less hydrophilic. An analogy I often use is a minefield; when a mine has exploded it cannot explode again, the same is true for hydrophilic groups on a surface. This type of hydrophilic surface is the most sensitive to humid air since it does not matter where the water molecules come from.
2. Water soluble hydrophilic species such as sugar, soap etc. These coatings are more stable in humid air but will dissolve in liquid water. Once dissolved the hydrophilic surface property is lost.

Actual hydrophilic surfaces will often have properties from both groups. The most stable surfaces can last for years in humid air, but all surfaces will degrade fast when in contact with liquid water.

Unfortunately, true permanent hydrophilic surfaces remain an unusually popular delusion. If they existed it would be a revolution in aircraft/car windows, diving goggles, cameras, optical systems etc.

Joninn products and services

Hydrophilic coatings. Our P100, S100, V100, K100, Q100 and H100 hydrophilic coatings all have contact angles in the low end 10°-15°. Our X100 hydrophilic coating complements P100 and S100, by enabling tuning of the contact angle between 10° and 45°. Our L100, L110 and L120 coating provide a lubricating surface when in contact with water.

Hydrophilic plastics. Our HydroPMMA, HydroPLA, HydroPE, HydroPP range of plastics are hydrophilic directly after the Injection moulding machine without a need for a coating.

We have extensive experience with optimization of the hydrophilic properties of customer devices. When we have an active consulting role with a customer, we have more than 90% success rate with reaching product specifications.