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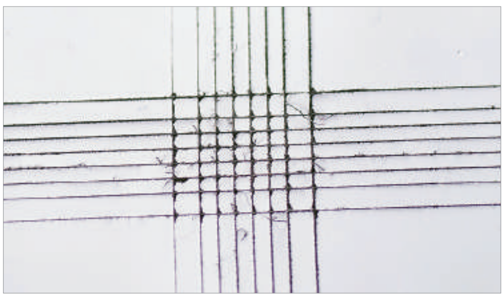
Plasma surface testing overview

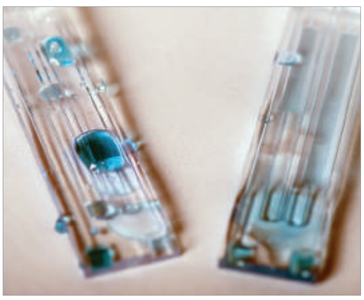
What is surface testing?

There are various quick and simple tests to determine the effectiveness of a particular plasma process upon a surface. The test methods have the benefit of being applicable to both un-treated and treated surfaces and so also provide a useful comparison before and after processing.

Surface Energy

Adhesion Tests





Test methods

Surface energy

Molecules within the body or bulk of a material are surrounded in all directions by other molecules. To create a surface some of these bonds must be broken, which requires energy. Some of this excess energy is 'stored' in the surface because the surface molecules are no longer surrounded on all sides by the same molecules as in the bulk; there are unsatisfied bonds on the surfaces.

Surface energy is defined as the excess energy at the surface of a material compared with the bulk material itself.

Now let's consider what happens when a liquid comes into contact with a surface. If the molecules of the liquid are attracted to each other more strongly than to the surface then the liquid won't wet the surface very well, instead forming beads. Conversely, if there is a larger attraction to the surface then the liquid will spread out more.

It follows that if a particular surface has a higher surface energy it will wet more easily and, since the ability to wet a surface is in turn a simple definition of the adhesion characteristics of the surface, it will be easier to glue/print/paint or bond to that surface.

Surfaces that have predominately carbon-hydrogen (C-H) bonds tend to have low surface energies and so do not wet easily e.g. wax. Surfaces that have lots of oxygen-hydrogen bonds (O-H) have higher surface energies and therefore better adhesion characteristics. Polyethylene and polypropylene are examples of low energy surfaces.

Plasma treatments aim to convert low energy surfaces to higher energy surfaces by attaching oxygen containing species to the surface. Other 'functional groups' can also be formed at the surface to give different and interesting properties.

Test methods

Test Fluids

Test fluids are a simple and inexpensive way to estimate surface energy and require no special training.

They are available in graduated energy level sets in the form of bottled ink with brush applicator or in the form of marker pens. In both methods increasing graduations (energy level) of the test fluid are simply drawn over the surface in turn. Low energy level fluids will bead up on the surface indicating that the surface energy is lower than that of the fluid used. When a particular fluid no longer forms beads but instead spreads evenly on the surface, the surface energy is approximately equal to that of the fluid.

Surface energy is usually given in units of dynes/cm or mN/m and the test fluids are available in blue, red or green colour. Blue fluids are formamide based (toxic) and are formulated to DIN ISO8296 which means that the results are comparable between different manufacturing sites or laboratories. Red and green fluids are alcohol based (non-toxic) and so strictly speaking not comparable between sites although usually absolutely fine for most instances.

Individual test fluid bottles

Individual 12ml Test Bottles with Brush Applicator				Table 1	
Blue		Green		Red	
Range	Increment	Range	Increment	Range	Increment
18-28mN/m	2mN/m	24-72mN/m	2mN/m	34-46mN/m	2mN/m
30-46mN/m	1mN/m	-	-	-	-
48-72mN/m	2mN/m	-	-	-	-
105mN/m	n/a	-	-	-	-

Test fluid bottles sets

Available in sets containing six (blue) or seven (green and red) individual bottles in a sturdy case.
Our most popular sets are shown in the table below.

Individual 12ml Test Bottles with Brush Applicator in Sturdy Case		Table 2
Blue	Green	Red
28, 38, 56, 64, 72 and 105 mN/m	24, 30, 36, 42, 48, 58 and 72 mN/m	34, 36, 38, 40, 42, 44 and 46 mN/m

Test methods

Test Pens

Quick test pens

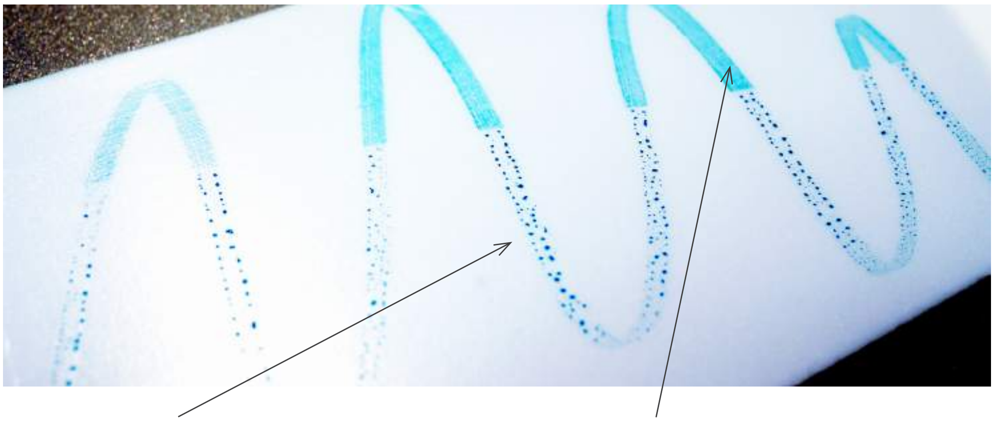
The Quick-Test pens are used as a quick quality test of whether or not a part has been plasma treated. They are refillable and come with a single 'setting' of 38 mN/m.

Test pen sets

Seven individual test marker pens in a clear carry pouch (red fluid energy levels from table 1 above).

Easy test pens

Easy-Test Pens are filled with 100ml fluid with any energy level from the green fluid range in table 1 above.



Surface energy less than 56mN/m

Surface energy greater than 56mN/m

Test for Silicone contamination

Silicones are polymers containing silicon, carbon and oxygen. Silicones can be present on many surfaces due to mould release agents or simply from leeching from 'clean' packaging, resulting in poor adhesion and bonding characteristics.

Unlike carbon based polymers however, only the organic functional groups can be removed by plasma treatment, leaving a non-volatile silicate surface.

A simple test method for the presence of silicone contamination on a surface will therefore highlight potential issues in manufacturing steps or indeed in post-treatment packaging that may affect an otherwise pristine plasma treated surface.

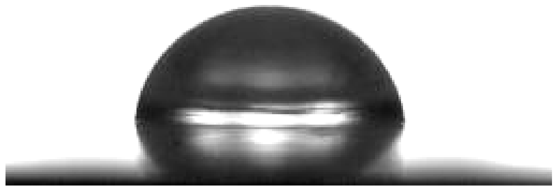
Silicone test kit

The silicone contamination test kit contains everything required to test for silicone contamination together with simple to follow instructions. it is available in a small hard carry case and therefore suitable for 'at-site' testing.

Contact angle measurement

Contact angle instruments can optically analyse the shape of a drop of liquid in contact with a surface. This is achieved with a fast image capturing camera and analysis software.

The drop shape and **contact angle** depend on the both the topography and the surface energy of the solid surface. When attracted to the solid (material with higher surface energy), the liquid forms a drop with low contact angle (theta < 90o). If repelled (material with low surface energy), the contact angle is high (theta > 90o). The contact angle is a quantitative measure of how well the surface is wetted by the liquid.



Static angle measurement mode

Static Contact Angle is primarily used to determine the wetting characteristics of a substrate to check surface treatment, cleanliness and/or contamination effects. The purpose of this test is to determine the highest possible contact angle at "equilibrium".

Dynamic angle measurement mode

In this test mode a sequence of images is automatically captured as soon as the falling droplet arrives on the specimen surface. Each recorded image is analysed and the result is presented as a curve showing the dynamic change in contact angle (wetting), volume (absorption) and spreading as a function of time. This test is particularly useful for troubleshooting problems related to dynamic processes such as printing, gluing and coating applications.

Pgx portable contact angle measurement

The PGx is a fully automated Contact Angle Measurement Instrument that measures surface wetting and absorption in-situ on virtually any size or shape of surface. With a footprint of only 90mm x 55mm and weighing just 400g, it is the smallest contact angle measurement device available, with features previously found only in larger laboratory instruments. The PGx enables direct surface testing of almost any 3D object without having to cut the sample to fit.

Specifications:

- 0.2uL to 10uL droplet size
- 80 frames per second image capture
- Touch down, impact and manual drop application modes
- Built in, automatic calibration
- Automatic sampling in both Static & Dynamic modes
- adhesion (gluing, bonding)
- absorption
- surface contamination (cleaning)
- wettability (printing, painting, coating)

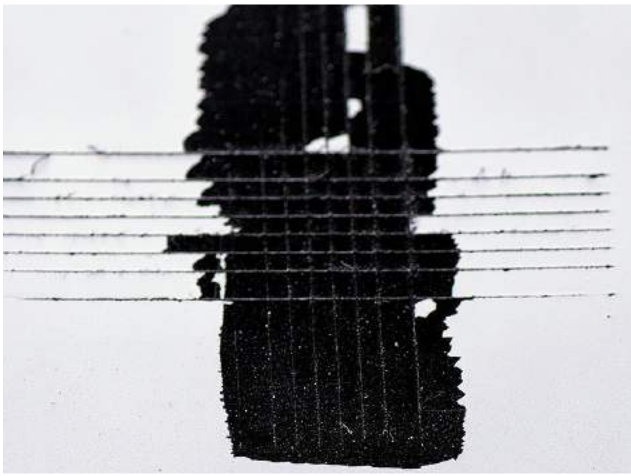
Adhesion grid cut test

The cross hatch adhesion tester is a simple and effective method for determining the coating adhesion on a wide range of materials. The adhesion tester is ideal for testing coatings on flat surfaces and is available with one of three different spacings;

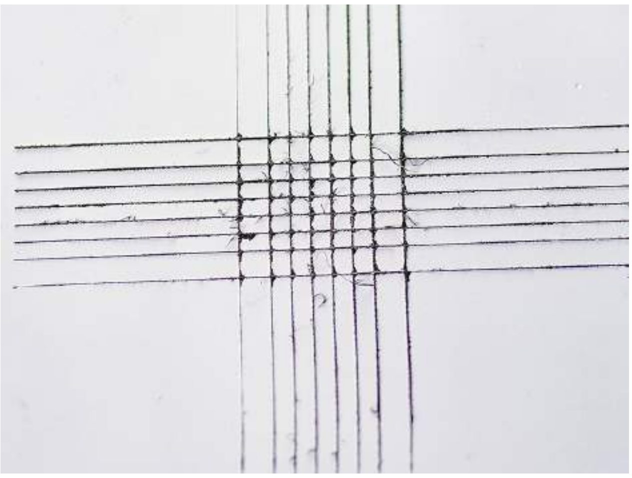
- 1mm spacing – for coating thickness <60μm (2.4mils)
- 2mm spacing – for coating thickness <125μm (5.0mils)
- 3mm spacing – for coating thickness <250μm (9.8mils)

Each cross hatch gauge can be supplied separately or combined in a kit with a standardised brush and x10 magnifier.

- Efficient cross hatch cutter with 8 cutting faces
- Anodised aluminium handle with a wheel for stable operation, ideal for test panels
- Supplied with an adjustment gauge for accurate positioning of the cutter face for better adhesion test results.



Before plasma treatment



After plasma treatment

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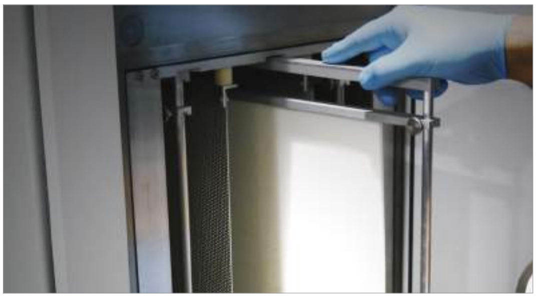

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