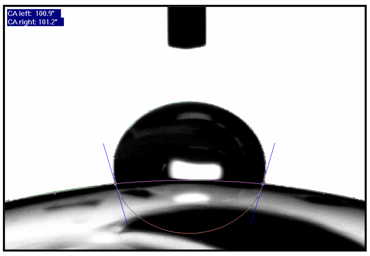
Determination of Surface Tension and 'Wettability' of Liquids on Solid Surfaces

In many applications the ability of liquids to wet solid surfaces is a fundamental factor in determining the performance of a product. Measuring the wettability can be used in product development or in quality control, the quality of products, their manufacturing processes or their performance at its end use.

Typical examples include; oils in engines in the automotive industry, waterproofing of building materials, inks in the printing industry, contact lens technology, agrochemicals and anywhere that a liquid comes into contact with a surface.

Fig.1 Water Droplet on a contact Lens Surface



LPD Lab Services has a diverse range of analytical equipment and industrial experience that allows the wettability and underlying surface chemistry of the surfaces to be measured. The physical property measurements of the liquid interaction on the substrate can be achieved by contact angle measurements using the optical contact angle measuring system (OCA) and the dynamic contact angle tensiometer (DCAT) coupled with microscopic surface topography. These assessments are quantitative and can be tied into changes in surface chemistry and can partner results generated from other surface analysis techniques particularly X-ray-Photoelectron Spectroscopy (XPS), Secondary Ion Mass Spectrometry (SIMS) or Auger Electron Spectroscopy (AES).

The physical behavior can also be affected by microscopic surface roughness that can have an effect on localised contact angles. These can be examined in the SEM. The combination of contact angle measurements, surface texture / roughness and surface chemical analysis can be used to unambiguously assess the affects of manufacturing process modification and formulation changes improving product performance or reliability of in-line processes such as paint coating, laminate or adhesive systems.

Determination of Surface Tension

Liquids with lower surface tensions generally tend to 'wet' solid surfaces better depending on the surface chemistry of the substrate. For determination of Surface Tension there are three possible routes of analysis using the OCA or DCAT:

-The pendant drop method is the universal method to measure surface and interfacial tensions and is undertaken using the OCA. A droplet of liquid is suspended in air and the droplet shape is a net result of two forces: Gravity elongates the drop and the surface tension endeavors to maintain the droplet in spherical form. The curvature of the drop is characteristic of the equilibrium state and is exactly mathematically defined by the Young-Laplace equation. Therefore, if the drop shape can be determined so can the surface tension.

-The other two possible methods use the DCAT and are known as the 'Wilhelmy Plate' or 'Du-Nouy Ring' methods. These methods use platinum-iridium standards that are submerged into the liquid held on a very sensitive set of scales. The weight changes recorded before, during and after being submerged in the liquids are used to determine the surface tension.

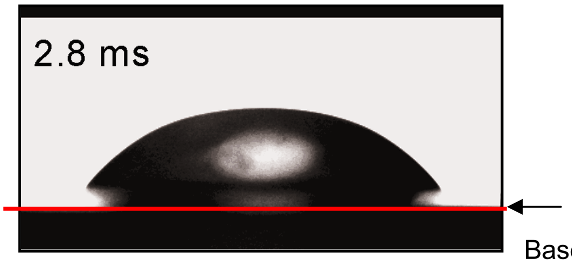
Determination of Contact Angle on a Solid Surface

The sessile drop method is the standard method used to measure contact angles and uses the OCA. A droplet of liquid is dispensed onto a solid surface. The sessile drop is illuminated from one side using a diffuse light source and viewed from the other side the contour of the drop is observed.

LPD Lab Services Limited

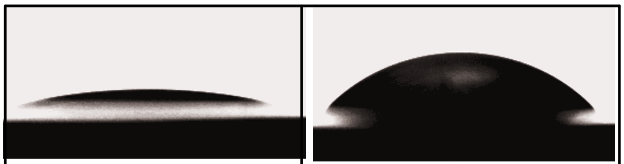
– a unique combination of analytical equipment, techniques, and investigative experience

Fig 2 Image of Sessile drop on solid surface using high speed camera to see rate of wetting



The baseline is first detected to indicate where the droplet ends and the surface begins. The droplet shape is determined and from this the contact angles can be calculated. Calculation of surface tension can again be calculated according to the Young-Laplace equation using these contact angle measurements.

Comparing different liquids, this method of analysis instantly shows if one liquid 'wets' a surface better than another. (see Fig.3 below). A high speed camera can also be used to measure the speed of wetting / contact angle change. Surface homogeneity can also be demonstrated using this method. If several drops of known liquid are dispensed onto a surface, differences in contact angles will indicate the degree of inhomogeneity of the surface.



Almost fully 'wets' surface	Droplet clearly doesn't fully 'wet' surface.

Fig.3 Two droplets of different liquids on the same surface - Demonstrating visually the difference in the liquids 'wettability'.

Case Study:- Testing Various Paints To Determine their Waterproofing Capability

Four pieces of wood were coated with one layer of each of the following paints: Matt, Gloss, Tile and Enamel paint. The aim of this investigation was to illustrate which out of the four different paint types provides the best waterproof coating of the wood surface.

The diagram in the next column shows what a droplet should look like on a waterproof surface. The larger the contact angle the more waterproof the surface is.

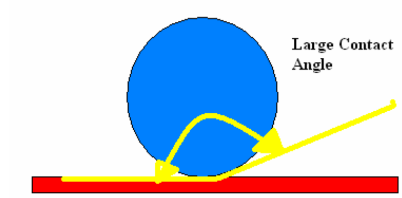


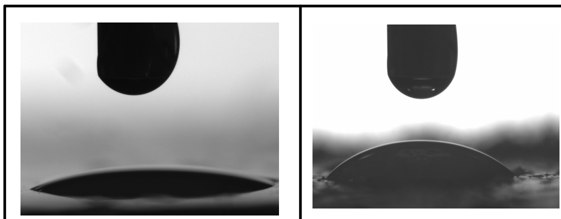
Fig.4 Schematic of droplet formed on waterproof surface

The OCA and sessile drop method was used to determine the contact angles of water on each of the surfaces.

The following results were obtained:

Paint Type	**Contact Angles**
Matt	Fully Wet Surface
Gloss	37.4° (left) 35.7 ° (right)
Enamel	41.6 ° (left) 42.2 ° (right)
Tile	57.3 ° (left) 58.3 ° (right)

It is clear from the pictures below and the contact angles calculated using the OCA that the tile paint has given the wood the most waterproof coating. The matt paint was absorbing the water, which is why it fully wetted out. This shows that this technique can highlight the differences in surface properties between samples



Gloss Poor waterproofing properties.	**Tile** Best Waterproofing properties.

Fig.5 Images of sessile drops produced during paint waterproof case study

Contact us today

Find out how we can help solve your problems in process improvement, process control and materials analysis

LPD Lab Services
Phone: +44 (0)1254 676074
E-mail: enquiries@lpdlabservices.co.uk
Web: www.lpdlabservices.co.uk