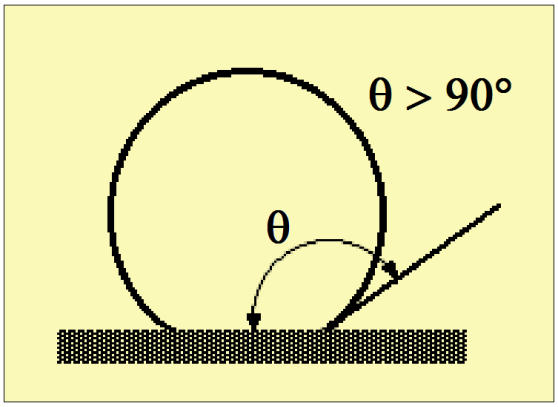
A practical means to measure surface treatment levels of PE Film using PGX+, a new portable contact angle instrument.

Contact angle measurements

The PGX + uses a liquid droplet (e.g. water) applied to the surface of the substrate in order to determine properties specific to the surface layer of the material. This is commonly referred to as a contact angle measurement using "the sessile drop method".



The contact angle is measured as the inward angle between the base and the tangent at the point of contact between the liquid and the surface. This value corresponds to the surface energy level in the equilibrium system formed between the liquid and the solid on the condition the surface is smooth, non-porous, non-sorptive, and homogeneous. Furthermore the liquid must not react chemically with the substrate.

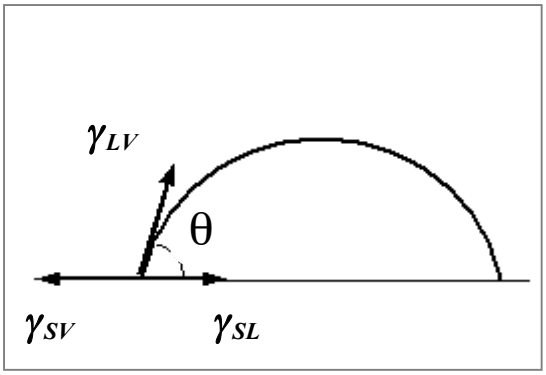
The relationship between a static contact angle and the surface energy forces was defined by Young [1] from the interfacial tensions:

$\gamma_{SV} = \gamma_{SL} + \gamma_{LV} \cos \theta;$

where γ_{SV} = *solid-vapour interaction*

γ_{SL} =*solid-liquid interaction*

γ_{LV} = *liquid-vapour interaction*



☞ ***"Wetting" is obtained if contact angle is ≤ 90°***

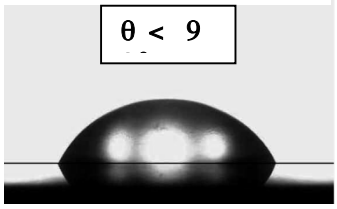
Static contact angles

A static contact angle occurs where the water droplet reaches an "equilibrium" condition and the dimensions of the liquid droplet would not change over time. This situation will normally occur for a non-absorbent substrate (e.g. liquid container board, release papers). This condition would also occur when a water droplet is applied to a copy paper because of its "hydrophobicity" (water repellence).

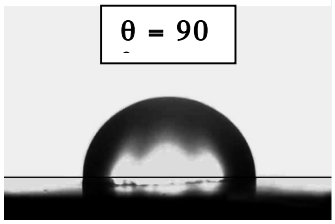
The static contact angle value is valid for smooth, non-porous surfaces not penetrated by the test liquid. The static contact angle will reveal if wetting is obtained (contact angle ≤ 90°) or not. The attached images of static contact angles are captured from water droplets applied on a reflecting plastic surface for illustration purposes.

☞ ***By definition, the base line is the lowest section of the droplet resting on top of the test surface.***

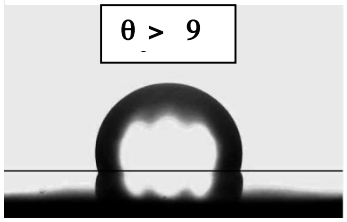
A "flying saucer"?



A "semi-sphere"?



A "snowman shape"?



Converters, film extruders and printers need to measure quality and consistency of film treatment to insure proper liquid to substrate adhesion.

For most companies, Dyne pens are used to provide this measurement. Surface test fluids such as dyne pens are the most economical and commonly used method to verify surface properties. However, numerous disadvantages exist with these devices. Test results using a dyne pens are extremely variable due to operator interpretation, have a wide range of inaccuracy from drying out and aging and are likely to become contaminated from improper use.

A dyne pen applies the test liquid which then "beads up" across the surface. This is what we refer to as the "receding contact angle" which is the lowest possible contact angle for a given surface. If you gently apply a small liquid droplet on a substrate it wets out by gravity (small force) and the surface wetting. This is the "advancing contact angle" and the highest contact angle for a given surface. The difference between these two contact angles is referred to as "wetting hysteresis" and is different for different materials. Very hydrophobic surfaces have in general a very low wetting hysteresis.

Dyne pens are easily contaminated as the felt tip /ball easily picks up contaminants from the test surface. This will lower the surface tension of the test liquid inside the pen and this will in turn incorrectly indicate a lower contact angle = higher surface energy = increased hydrophobicity at the surface

What are the advantages of using the PGX + over the Dyne Pen?

Dyne pen measurements are based on the user observing the wetting behavior as the liquid is applied to the film. The result is very subjective to a visual interpretation.
The PGX+ contact angle measurement provides calibrated and traceable test results based on a well-established scientific measurement principles which are operator independent.

What are common test applications for the PGX + Contact Angle instrument?

The PGX+ is commonly used to investigate the effect of surface modification after plasma treatment or chemical cleaning. Applications can include plastic film, glass, silicon wafer, electronics and paper products.

What procedure is used to make the measurement?

The procedure is very simple. It is just only water drop application on surface of last layer. Base material is glass, film, Silicon, metal and others.

Can we convert dyne values into water contact angle?

Yes, a conversion chart is listed below.

Appendix C

Surface Energy Conversion Chart

Conversion chart	
Water Contact Angle	*SFE (dyne/ cm)*
51-53	46
54-56	45
57-59	44
60-62	43
63-65	42
66-68	41
69-71	40
72-73	39
74-76	38
77-79	37
80-81	36
82-84	35
85-87	34
88-89	33
90-92	32
93-95	31
96-97	30
98-100	29

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