



**This report describes how ACCU DYNE TEST™ marker pens can be used to measure the surface energy of films and other non-absorptive substrates.** This method parallels ASTM Std. D2578<sup>1</sup>, which covers the testing of polyethylene (PE) and polypropylene (PP) films via the application of formamide/ethyl Cellosolve\* solutions. The fluids used in ACCU DYNE TEST™ marker pens are based on those specified in ASTM D2578; the critical difference between this test and the ASTM technique is the manner in which the fluids are applied to the test sample.

In general, the ability of a substrate to anchor inks, coatings, or adhesives is directly related to its surface energy. If the substrate surface energy does not significantly exceed the surface tension of the fluid which is to cover it, wetting will be impeded and a poor bond will result. Thus, for most solvent based printing, plastics need to be treated to 36 to 40 dynes/cm; water based inks usually require 40 to 44 dynes/cm; some laminating and coating applications require surface energies of 50 dynes/cm or more. Clearly, surface energy must be assessed before printing, coating, or laminating is attempted.

ACCU DYNE TEST™ marker pens perform well on most non-absorptive materials. It is critical that the test fluid does not alter the surface properties of the substrate. For example, if the test fluid permeates a fibre substrate (such as paper) and causes swelling, results will indicate unrealistically easy wetting. A chemical reaction between the test fluid and the substrate invalidates results altogether.

To ensure replicability of this test, material preparation and test technique must be standardized. ASTM Std. D618<sup>2</sup> documents suggested conditioning methods. Unfortunately, this standard is untenable for treated film testing; conditioning times range from 24 to 96 hours. Such rigorous controls may be of value for R & D, but for normal QC testing, much shorter conditioning times should be used. Standardization of ambient, substrate, and test solution temperature is critical, as is inspection methodology. Have one trainer instruct all testers to minimize variability. Relative humidity should not be excessive; higher RH tends to increase data variability. Finally, the elapsed time between extrusion or coating to test (or from test to printing, etc.) must be controlled.

# TEST PROCEDURE

## ***IMPORTANT SAFETY NOTICE:***

The fluids contained in ACCU DYNE TEST™ marker pens are considered hazardous materials. Avoid contact with skin. Use with adequate ventilation. Avoid contact with eyes. Pregnant women should not perform this test. For further information, refer to product MSDS or call Diversified Enterprises at 800-833-4644 or (603)543-0038.

*For the results of this test to be meaningful, the following four points are absolutely essential and must be followed:*

- 1) Do not touch or in any way contaminate the surface to be tested. Dirty surfaces lose their wettability.
- 2) Do not use contaminated or outdated ACCU DYNE TEST™ marker pens.
- 3) Never retest the same location on a sample; move along the sample, or pull a new one.
- 4) Store and use ACCU DYNE TEST™ marker pens at room temperature.

## **1.0 Materials/Equipment**

1.1 ACCU DYNE TEST™ Marker Pens

1.2 Subject Material

1.3 Clean Level Test Area

1.4 Thermometer and Hygrometer

## **2.0 Method**

2.1 Pull test sample. Be sure to pull a good specimen; surface aberrations cause poor results. For extruded film, one entire web cross-section should suffice. Do not touch the surface.

2.2 Place the sample on a clean, level surface. If necessary, anchor the edges to avoid curling or other deformation.

2.3 Record ambient temperature and relative humidity. If sample temperature differs from ambient, allow it to stabilize.

2.4 Test at least three points across the sample; 1/4, 1/2, and 3/4 across the film section. It is good practice to test the outer edges as well. For non-film materials, test locations must be determined in-house.

2.5 Determination of Wetting

2.5.1 Choose an ACCU DYNE TEST™ marker pen of a dyne level you believe is slightly lower than that of the test sample.

2.5.2 Press applicator tip firmly down on subject material until the tip is saturated with ink.

2.5.3 Use a light touch to draw the pen across the test sample in two or three parallel passes. Disregard the first pass(es); to flush any contamination from the tip, and to ensure that the test fluid layer is thin enough for accurate measurement, evaluate only the last pass.

2.5.4 If the last ink swath remains wetted out on the test sample for three seconds or more, repeat steps 2.5.2 and 2.5.3 with the next higher dyne level marker. If the last ink swath beads up, tears apart, or shrinks into a thin line within one second or less, repeat steps 2.5.2 and

2.5.3 with the next lower dyne level marker. If the ink swath holds for one to three seconds before losing its integrity, the dyne level of the marker closely matches that of the sample.

This is a relatively accurate surface energy measurement technique; used in standard 2 dyne/cm increments, ACCU DYNE TEST™ marker pens can generally produce results with a precision of +/- 2.0 dynes/cm. Repeated use of ACCU DYNE TEST™ marker pens should enable testers to estimate surface energy to within +/- 1.0 dyne/cm.

To investigate discrepancies between obtained and expected results, a more precise measurement method should be considered; application of ACCU DYNE TEST™ surface tension test fluids with cotton swabs (per ASTM D2578-84) or by use of a drawdown rod is recommended. Alternatively, if results are suspect, replicate the test with a set of unused markers. This test has proven itself on a wide variety of substrates; it is, however, theoretically more prone to contamination than some other techniques. For this reason, even in the absence of unexpected results, you should establish a quality assurance plan which calls for regular audits during the phase-in stage of ACCU DYNE TEST™ marker pen use. The effect of **all** changeovers from one substrate to another should be monitored especially closely. Slip and other additives tend to bloom to the surface of extruded sheets and films; transferring surface-active additives from one material to another can have a profound effect on surface energy measurement. In general, once you demonstrate that a switch from substrate A to substrate B has no effect, it is safe to assume that future changeovers from A to B will act similarly. Thus, the frequency of backup audits decreases over time.

Finally, a few qualifying words. Surface energy is critically important to many converting operations. Unfortunately, it is not the sole determinant of product suitability. Other factors, such as surface topography, coating rheology, and chemical incompatibility, must also be considered. This is why broad-based communications with vendors and customers is so important. But at least by systematically measuring substrate surface energy, you will have a sound starting point from which to resolve other problems which may arise.

<sup>1</sup>Annual Book of ASTM Standards, *Wetting Tension of Polyethylene and Polypropylene Films*.

<sup>2</sup>Annual Book of ASTM Standards, *Conditioning Plastics and Insulating Materials for Testing*.

\*ethyl cellosolve is a registered trademark of Union Carbide Corp. for ethylene glycol monoethyl ether (2-ethoxyethanol).

Content supplied by Russ Smith President of Diversified Enterprises

Manufacturers of Accudyne Dyne pens.