Evaluating the Physical Properties of PSA Tapes

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I am Boine Johnson, President of Texture Technologies Corp of Scarsdale, NY and I will be discussing today some of the newer ways to measure various physical properties of PSA tapes. Traditionally 90 degree and 180 degree peel tests and/or tack measurements with a Polyken tact tester have been the second-generation tests following the original rolling ball test methods. Later in this presentation we will show some improvements in the peel tests, but the main thrust will be in the adhesive test methods utilizing the TA.XT2i from Stable Micro Systems of Godalming, Surrey in the UK.

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In recent years, many in the adhesive industry have been searching for more sensitive tests to measure the effects of formulation changes, processing changes and changes in film and backing materials upon PSA tape performance. Also recently, a great deal of interest has been expressed in medical applications, for transdermal medical delivery systems, for wound closures and dressings and for internal applications of medicines, all using PSA type products. To obtain the sensitivity needed one must also dramatically enhance the repeatability so that a small test sample can truly be representative of the actual results. Traditional tests are not sensitive or repeatable enough to meet the needs in both the R&D labs and for QA/QC on the factory floor.

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Many of you were present in May 1997 at the PSTC meeting in Boston when Ken Chuang of Avery Dennison first showed a test method using the TA.XT2i that he at the time called an Avery Adhesive Tester. Copies of a reprint of that paper as Published in Adhesives Age can be obtained from Texture Technologies Corp either at our exhibit (#314) or contacting us directly in Scarsdale, NY.

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The TA.XT2i with a 5 kg capacity and 0.1 gram force resolution with a distance resolution of 1 micron is best suited to PSA tapes measurements. The TA.XT2i can control all the parameters of the test methods that are needed for the new PSA tests. The Texture Expert for Windows software or the later version for use with NT, Texture Expert Exceed both allow easy control of test settings, monitoring of the test during its performance and the automatic calculation of key parameters and presentation and storage of results in Excel type spreadsheets.

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Fixtures for holding samples in place and probes for doing the test contacts will be discussed later, but let's discuss the test parameters the operator must control to obtain the optimum repeatable test results. With the TA.XT2i there are three speeds available during the test. The Pre-Test Speed is the speed the probe travels through the air prior to it contacting the sample surface. The surface is defined with the Auto trigger force that may be set as low at 0.5 grams. At the sample surface the probe speed shifts to the Test Speed and the probe works against the PSA tape surface until a target Force is achieved. The probes is then directed to dwell on PSA tape surface at the directed force for a given Time and then the probe withdraws from the surface at a Post-Test speed to a selected
**distance.** All speeds can be independently selected from a minimum of 0.01 mm/sec to a maximum of 10 mm/sec. Force can be from a minimum of a 0.5 g trigger force to a maximum of 5,000 g applied force and a dwell time can be set as low as 0.01 seconds to as many as 30,000 seconds.

Our users testing PSA tapes frequently use a 1 mm/sec pre-test speed, a 0.1 mm/sec test speed and a 0.5 mm/sec post test speeds. Trigger force is normally set at 5 g and the applied force is 450 g, but different applications call for different parameters, but more about that later.

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The result of a typical PSA tape test can be seen on the computer monitor shown here. This graph is the basis of much of the TA.XT2i work on adhesive testing and let me spend a moment to point out the key components of the curve and test results.

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This adhesive graph would be analyzed by what is called an adhesive macro and the results automatically inserted into the Results format shown. Not all parameters are useful or needed for any given product’s analysis so the macro and the results file are easily changed.

Chuang et al attached his sample tape to the platform with double sided sticky tape and used a 1” diameter stainless steel ball as the probe. Taking that as a starting point we have developed our TA-303, which is an Indexable Rig for PSA tape testing.

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The rig has a heavy brass plate with ten 10mm diameter openings. A piece of tape 6 inches long and 1 inch wide is placed on a flat surface adhesive side up, and the brass plate is placed on top with the adhesive side of the tape showing through the openings of the plate. The plate is placed in the rig and indexed along so that a total of 10 tests may be performed. The probe is a stainless steel cylinder probe 7 mm in diameter with a very shallow 1” radius on the bottom. It is strongly recommended that the probe must be cleaned with a solvent such as acetone prior to each test to prevent carryover from one test to the next. Also, clean it prior to the first test to remove oils from fingers testing the probe.

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Let me address some of the issues of probe selection and test parameters. This slide shows Hammond’s work on the effect that probe composition has on measured peak withdrawal force under constant parameters. We have made probes of dozens of materials from ABS to glass to aluminum, to wood, but stainless steel seems is to us as the initial best starting point for most tests and it has the ability to enhanced perceived relative tack.

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Many observers have questioned using a rounded probe since for years the Polyken Tack Tester used a flat probe and we suggest that one of the reasons the Polyken produces high variability in peak tack force is that the Polyken probe is flat and small air bubbles are trapped during force application which cause uneven contact and thus uneven results.
This slide shows tests of identical electrical tape, duct tape and packaging tape under identical conditions using a TA.XT2i except that in the left hand graphs a flat 7mm probe is used and on the right a 7mm probe with a 1” radius is used. In the case of the electrical and packaging tapes, the %c.v. of the peak forces of the radius probe tests are dramatically reduced from the flat probe results. The duct tape tests results are better with the rounded probes but not nearly so dramatically as the others. These results are due to the softer and thicker adhesive of the duct tape and thus more involvement of the probe with the adhesive surface.

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This slide shows the resulting effect of different amounts of withdrawal speeds.

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Shown is the effect of different amounts of applied forces speeds on the adhesive curve. It takes a very expensive drive and sensing mechanisms to control exactly the applied force and applied force control is a major advantage of the TA.XT2i over the Polyken tack tester.

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We recently did an analysis of certain adhesive characteristics of a series of children’s adhesive bandages. Our users tell us that the peak adhesive force or tack is highly correlated with pain during removal. The area under the curve is the work of adhesion that holds the bandage in place. The distance is the parameter that allows the bandage to move. As you can see Tsumuraa has made exactly the wrong bandage for children. It’s painful to remove and it does not move while the kids muscles move. 3 M and Curad have done the right thing. We have a user making a patch adhesive, which holds electrodes in place in neonatal intensive care units where we are told that the peak withdrawal force can not exceed 20g, or internal organs may be disrupted, or in the case of geriatric patients, skin may be removed. Adhesive bandages for professional football players where the purpose of the bandage is to restrain something, so one would want to minimize distance and peak force is not an issue. Post-It-Notes have different curves of course.

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Let me share with you certain other test fixtures. Our TA-310 shows the rig used for testing adhesives tapes against release liners. Both the release liner and the PSA tape may be independently indexed.

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The TA-303 and the 310 each look at a total PSA system consisting of the adhesive and the film or tape. Our users asked for a way to use the TA.XT2i for testing parameters of films and tapes and the standard tensile grips require a great deal of effort and preparation of the sample to grab the film. We have developed our TA-108S. A film and Gel extensibility fixture. A sample as small as 15mm x 15mm can be placed over the opening and locked in place and a 1/8” ball probe can be used to test resilience and burst strength.

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A Peltier plate may be used to control surface temperature in the range of 20 F to 175 F.
A thermal cabinet may be used to control temperature from –60 C to 200 C.

Finally, the TA.XT2i may also be used for 90 degree and 180 degree peel tests. This slide shows the 90 degree peel rig.

This graph shows the results of certain peel tests of four tapes. We recommend that you take an average peak force over say 80 mm of travel, the area under the curve or work for that distance and then the number of peaks at various thresholds for a measure of the tapes smoothness and quality of coating.

These are some of the users of the TA.XT2i for adhesive testing for tapes and other products, but PSA tapes and suppliers to the tape industry are a significant component of the list.

I thank you for your attention and are there any questions?