

**Project PAJ1: Failure criteria and their application
to Visco-Elastic/Visco-Plastic materials**

Report 5

**Review Of Methods For The
Measurement Of Tack**

Prepared by R A Roberts

September 1997

Contents

1 Introduction	3
2 Test methods	3
2.1 BS 7116: 1990 Double sided pressure sensitive adhesive tapes	3
2.2 BS EN 1945: 1996 Self-adhesive tapes - measurement of	3
2.3 BS EN 1719 (pr EN 1719) (draft) Adhesives - tack measurement for pressure sensitive adhesives - determination of loop tack	4
2.4 FINAT test method no. 9 (FTM 9)	4
2.5 BS EN 1721 (pr EN 1721) (draft) Tack measurement for pressure sensitive adhesives - determination of rolling ball tack	5
2.6 ASTM D3121-94 Standard test method for tack of pressure sensitive adhesives by rolling ball	5
2.7 ASTM D2979-95 Pressure sensitive tack of adhesives using an inverted probe machine	6
2.8 Comparison of tack methods	6
3 Test method reviews/general articles	8
4 References	10

1 Introduction

A search of the Pira 'Packaging Database' produced a total of 25 abstracts relating to tack; Infodisk produced further references to standards. The articles ranged from reviews of methods of measuring tack and test methods, to articles that only briefly reported the use of a particular test within testing of other material properties.

Four basic methods for measuring tack were described. These are:

- loop tack
- rolling ball
- "Quick stick"
- probe measurement devices.

The more relevant papers and test methods are summarised below. References to the measurement of hot tack have not been included.

2 Test methods

2.1 *BS 7116: 1990* **Double sided pressure sensitive adhesive tapes**

The standard specifies requirements for classification, dimensions, shear adhesion, thickness, peel adhesion and packaging of double sided pressure sensitive adhesive and transfer tapes.

Within this standard, (Appendix G) determination of loop tack is defined for both the open and closed side adhesive. The tape is attached to a flat substrate and loaded with a 2kg mass for 1 minute. A clean loop of 23 μ polyester film is brought into contact with the adhesive and withdrawn at 300 mm/min. The contact area is 25mm x 25mm. The maximum force to remove the polyester tape is recorded.

2.2 *BS EN 1945: 1996* **Self-adhesive tapes - measurement of "Quick stick"**

"Quick stick" is defined as the property of an adhesive that causes an instant bond with a measurable separation force by the touching of the adhesive and a substrate with little or no externally applied pressure. The surface of the adhesive has an influence on this property.

A length of adhesive tape 25mm wide is applied to a standard metal plate under standard conditions - a roller is used to apply light pressure.

The “Quick stick” is the force to peel the tape from the plate at 90° and 300 mm/min within 1 minute of application.

2.3 *BS EN 1719 (pr EN 1719) (draft) Adhesives - tack measurement for pressure sensitive adhesives - determination of loop tack*

Loop tack is defined as the force required to separate, at a specified speed, a loop of adhesive coated material that has been brought into contact with a specified area of a defined surface.

The adhesive is coated (25g/m²) onto 50µ polyester film, covered with a release paper and allowed to condition for 24 hours. The adhesive coated strip is brought into contact with a glass or metal plate at 300 mm/min and when a contact area of 25mm x 25mm has been achieved is immediately reversed and withdrawn, and the maximum force recorded.

2.4 *FINAT test method no. 9 (FTM 9) “Quick stick” tack measurement (loop tack)*

This test method describes a means of assessing the tack of a pressure sensitive material. It is supposed to allow the end user to compare the “initial grab” or “application tack” of different laminates and is useful for those working with automatic labelling equipment.

The “Quick stick” tack value is expressed as the force required to separate at a specified speed a loop of material (adhesive outermost), which has been brought into contact with a specified area of a standard surface.

A strip of material 25mm wide and at least 175mm long is formed into a loop and brought into contact with a glass plate at 300 mm/min. Immediately a contact area 25mm x 25mm has been achieved, the loop is withdrawn at 300 mm/min and the maximum force to separate the loop from the glass plate is recorded. This is often referred to as loop tack.

2.5 BS EN 1721 (pr EN 1721) (draft) Tack measurement for pressure sensitive adhesives - determination of rolling ball tack

Rolling ball tack is defined as the distance a rolling ball travels on an adhesive layer before stopping, after it was allowed to roll down a defined incline.

An adhesive sample is coated 25g/m² onto 50µ polyester film, covered with a release paper and allowed to condition for 24 hours.

A clean steel ball 10mm in diameter is released and runs down an inclined track 160mm long at an angle of 21° 30'. The distance the ball travels along the horizontal on the adhesive track is measured.

2.6 ASTM D3121-94 Standard test method for tack of pressure sensitive adhesives by rolling ball

This is similar to BS EN 1721 but the ball diameter is 11.1mm, and the adhesive can either be coated onto a surface or any adhesive tape can be used.

The standard states there are two major retarding forces applied by the adhesive to the ball:

- (1) the adhesion between the ball and the adhesive, often called “grab”
- (2) the “plowing effect” or energy required to push the adhesive out of the ball’s path.

Test results are influenced by:

- (1) adhesive film thickness
- (2) bonding of adhesive to backing
- (3) backing rigidity.

Significance and use

The rolling ball tack test is fast, easy to run and requires little investment. The test is intended primarily for quality control since it demonstrates good reproducibility within a single laboratory and the ability to detect batch to batch variations if the adhesive film is held constant.

It is not intended as an investigative tool since for most pressure sensitive applications rolling ball tack results do not correlate well with application tack requirements.

2.7 *ASTM D2979-95* Pressure sensitive tack of adhesives using an inverted probe machine

The test is applicable to those adhesives that form a bond of measurable strength rapidly upon contact with another surface and which can be removed from that surface cleanly. Tack is measured as the force required to separate an adhesive from the adherend at the interface shortly after they have been brought into contact under a defined load of known duration at a specified temperature.

The tip of a cleaned probe, 5mm in diameter of defined surface roughness, is brought into contact with an adhesive at a controlled rate under a fixed pressure for a short time and subsequently the bond formed between the probe and adhesive is broken at a controlled rate. Tack is measured as the maximum force required to break the bond. Contact and removal speeds are 600 mm/min. The adhesive is either cast onto a rigid support or used as a tape. Contact pressures of 0.98, 1.96 or 4.90 kPa are obtained by using annuli of different weights.

Significance and use

The test method provides a quantitative measure of the pressure sensitive tack of the adhesive. It is designed for the adhesive mass itself and is suitable for measuring the tack of pressure sensitive adhesives for use on both rigid and flexible backings. It is suitable for quality control and research purposes.

2.8 Comparison of tack methods

[Reference 1](#) compares test methods for measuring tack and the following table is based on Table III in that reference.

Common name	Organisation	Method	Comments
Probe tack	ASTM	D2979	Only test procedure defining this technique
Rolling ball	ASTM PSTC BS EN	D3121 6 1721	Identical to ASTM D3121 Similar to ASTM D3121
Loop tack	FINAT TLMI TLMI	FTM 9 LIB 1 LIB 2	Similar to FTM 9 but uses a stainless steel surface not glass Same as LIB 1 but uses an adapted tensile tester rather than a specially designed piece of equipment
“Quick stick”	BS EN AFERA PSTC	1945 4015 5	BS EN 1945 and AFERA 4015 are identical and use a 25g roller to apply the test specimen to the panel, whereas the PSTC method uses only the weight of the test strip to accomplish lamination

Table 1: Comparison of tack methods

Abbreviations and Addresses

PSTC	Pressure Sensitive Tape Council 401 North Michigan Avenue, No. 2200, Chicago, IL 60611426 USA Tel: 00 1 312 644 6610 fax: 00 1 312 527 6640
TLMI	Tag and Label Manufacturers Institute 40 Shuman Blvd, Suite 295, Naperville, IL 60563 USA Tel: 00 1 630 357 9222 fax: 00 1 630 357 0192

AFERA Association des Fabricants Europeens de Rubans Auto-Adhesifs, 60 rue
Auber, 94408 Vitry Sur Seine Cedex, France
Tel: 00 33 1 49 60 57 87
fax: 00 33 1 45 21 03 50

FINAT Fédération International des Fabricants et Transformateurs d'Adhésifs et
Thermocollants sur Papiers et Autres Supports
Laan Capes van Cattenburch 79
NL-2585 EW Den Haag, The Netherlands
Tel: 00 31 70 360 38 37
fax: 00 31 70 363 63 48

3 Test method reviews and general articles

- 3.1 R. P. Muny “Getting the Right Results: A Review of PSA Testing Methods”,
Adhesives Age August 1996.

This is a recent review of PSA test methods covering peel, shear and tack testing. It compares the test methods of the various standards and trade associations and also briefly comments on the usefulness of the test procedures:

- rolling ball - one of the earliest of tack methods. Care must be taken as it measures not only the tack but also softness and mass of adhesive
- loop tack - relies only on the lamination pressure that is contributed by the stiffness of the test sample
- “Quick stick” - as described by PSTC and AFERA measures instant adhesion but the residence times in these methods are relatively longer than other tack methods.

- 3.2 J. Johnston “Tack”, TAPPI Hot Melt Symposium 1984 and
“Tack”, Adhesives Age, November 1983, December 1983.

These are basically the same paper. The paper reviews tack test methods starting from the thumb tack test and then describing the development of:

- loop tack testing
- rolling ball
- probe tack testing methods.

The probe testing was initially proposed by Wetzel, but was not available commercially. It was modified to a simpler version by Hammond and Kendall, and is now often known as the Polyken Probe Tack Tester. The probe is attached to a force gauge, and the sample to be tested is attached to an annular weight to control the applied pressure and is lowered onto the probe and plucked off. The basic machine is arranged to give 100g/cm² pressure with a 5mm diameter probe, a contact time of 1 second and a rate of removal of 1cm/sec.

The paper then briefly discusses the interpretation of data.

- 3.3 ASTM, Special Technical Publication No. 360 - Symposium on Recent Developments in Adhesive Science 1963
F.H. Hammond - "Polyken Probe Tack Tester".

This is some of the original work referred to in reference 2.

- 3.4 P.J.C. Counsell and R.S. Whitehouse "Tack and Morphology of Pressure Sensitive Adhesives", Chapter 4 in Development in Adhesives - 1, editor W.C. Wake 1977.

A description of tack test methods is followed by a discussion of the effect of parameters on tack results such as duration of contact, temperature and rate of testing, and it is demonstrated that for viscoelastic adhesives the rate/temperature transformation of Williams, Landel and Ferry can be applied to tack data.

The paper then goes on to examine the morphology of adhesive films.

- 3.5 Testing of Adhesives, TAPPI Monograph No. 35 1974
Editor R. Gregory Messe.

This is a general text book dealing with the testing of adhesives but two chapters are relevant:

Chapter 12 - pressure sensitive adhesives	pp 180-192
Chapter 13 - tack testing	pp 192-199

However, the information is of a very general nature and the methods of tack testing add nothing to that in the published test methods and other articles.

- 3.6 Other Articles

Other articles (references 8 to 17) refer to the use of tack testing by various companies to compare adhesives, but in general the data is patchy and there is little comparison between test methods. Reference 13 probably provides the most information.

- 3.7 The Fipago Adhesion tester - TAPPI March 1978 Vol. 61
TAPPI Useful Method 563 - Adhesiveness of Gummed Paper Tape (Werle Tack Tester).

These two articles describe a test method for evaluating the performance of remoistenable gummed tapes, including measurement of the tacking rate of the moistened tape to a substrate (wet tack) and the degree of adhesion of gummed tape bonded to a substrate, after drying, following its application and at intervals of delay after moistening (open time quality).

4 References

1. Muny, R.P. Adhesives Age Vol. 39, no. 9, Aug 1996 pp 20-22, 24 "Getting the right results: a review of PSA testing methods".
2. Johnston, J. TAPPI 1984, Hot Melt Symposium, San Diego, 3-6 June 1984, pp 85-93, "Tack".
3. Johnston, J. Adhesive Age Vol. 26, no. 12, Nov 1983 pp 34-38 "Tack - Known by many names, its difficult to define (Part 1)".
4. Johnston, J. Adhesive Age Vol. 26, no. 13, Dec 1983 pp 24-28 "Tack - Probe Testing and the Rate Process".
5. Hammond, F.H. ASTM Special Technical Publication No. 360, Symposium of Recent Development in Adhesive Science, 1963 "Polyken Probe Tack Tester".
6. Counsell, P.J.C., Whitehouse, R.S. 1977 Developments in Adhesives - 1, Editor W.C. Wake, Chapter 4 "Tack and Morphology of Pressure Sensitive Adhesives", London, Applied Science Publishers.
7. Meese, R.G. TAPPI Monograph No. 35, Atlanta Ga 1974 pp 212.
8. Schmit, M.C. TAPPI Vol 61, No. 3, March 1978 pp 53-56 "The Fipago Adhesion Tester: Tack Testing of Gummed Tape".
9. TAPPI Useful Method Vol 563, 1976 2pp "Adhesiveness of Gummed Paper Tape (Werle Tack Tester).
10. Wollum, M.H., Mellot, J.W., 1996 Hot Melt Symposium, Phoenix, Arizona, USA. 16-19 June 1996, pp 193-204 "The Effect of Diblock Addition on HMA/PSA Performance".

11. Dougherty, D.J., 1994 Hot Melt Symposium, Hilton Head, SC, USA. 19-22 June 1994, pp 115-123 “New Modified TPE Polymers”.
12. Stratton, W.M., Adhesive Age Vol. 28, No. 7, June 1985, pp 21-23 “High Shear PS Emulsion Works at High Temperatures”.
13. Maletsky, A., Villa, J., Int. J. Adhesion Adhes, Vol. 3, No. 1, January 1983, pp 53-56 “Ultra-violet Resistant Pressure Sensitive Hot Melt Adhesives”.
14. Gonsalves, A., Adhesive Age, Sept 1981, pp 38-40. “Hot Melt Adhesives: Interpreting the Data”.
15. Yingling, D.M., Antlfinger, G.J., PSTC 3rd Seminar Adhesive Coating Technology, 18-19 June 1980, Rosemont, IL “Compounding of Acrylic Pressure Sensitive Latexes”.
16. Fries, J.A., Pap. Film Foil Converter, Vol. 53, No. 3, March 1979, pp 62, 64, 66, 68 “PS Adhesives: An overview - Part II”.
17. Fox, R.A., Adhesives Age Vol. 20, No. 10, Oct 1977, pp 35-37 “Modifiers for Thermoplastic Elastomers”.

Prepared by: Richard A Roberts
Principal Consultant
Packaging Technology Group