# Assessing tackiness and adhesion using a pull away test on a rotational rheometer

RHEOLOGY AND VISCOSITY

## Introduction

Tack or tackiness in the context of material behaviour is associated with stickiness and may result from adhesive forces between two materials in contact or cohesive forces in a material bridging two substrates.

For pressure sensitive adhesives including tapes and labels, tack is defined as the ability to form an adhesive bond to a substrate under slight pressure and brief contact and is an essential requirement for such products. For other materials and applications tack may be an unwanted property, an example being bone cements, which according to ISO5833 must be tack-free, to allow the user to shape and apply the cement without adhering to gloves or application aids.

Tack may also influence the behavior and perception of consumer products, examples being the extrusion of thick viscoelastic products such as toothpaste from tubes or chewing or handling of sticky foods. It may also be used to assess the properties of a surface and judge whether it is clean or not. Therefore, a qualitative assessment of tack can be made simply through touch or feel, however, such assessments are subjective, difficult to quantify and may be influenced by other additional factors.

For many research and development activities it can be useful to screen, compare and quantify 'tack' or 'stickiness' using a simple objective test. For the adhesives industry there are many such standard tests available depending on the product type, including tests such as loop tack, quick stick and rolling ball tests.

This application note relates to another test which is commonly used in the adhesives industry, known as the inverted probe test. In this test an inverted probe is brought in to contact with the adhesive at a fixed speed, contact pressure and contact time. The tack is then recorded as the maximum force required to break the resultant bond.

While an equivalent test to this can be made with the Kinexus rotational rheometer, this application note discusses a more general test applicable to a wider range of materials. It involves measuring the force required to separate two parallel plates having a defined volume of material between them from a stationary position with no initial pressure applied.

Here the peak in negative normal force (tension) can be attributed to 'tack', the area under the force-time curve to adhesive or cohesive strength and the time taken for the peak force to decay by 90% a comparative measure of failure rate or time as illustrated in Figure 1.

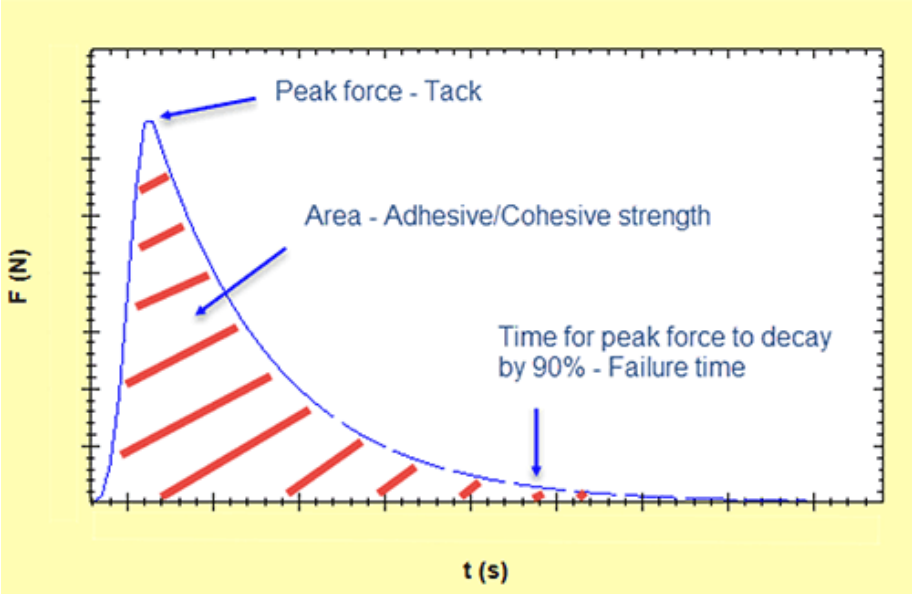


**Figure 1: Annotated normal force-time profile showing key features for assessing adhesive/ cohesive properties under tension**

## Experimental

- Tack properties of three different commercial products were measured and compared in this study - Hair wax, Toothpaste and Honey
- Tack measurements were made using a Kinexus rotational rheometer with a Peltier plate cartridge using matched 20mm upper and lower plates and standard pre-configured sequences in the rSpace software.
  A standard loading sequence was used to ensure samples were subject to a consistent and controllable loading protocol, with a working gap of 100 microns employed and sample trimmed flush with the plate edge. The working gap was automatically adjusted prior to measurement to ensure applied force was zero at start of the measurement.
- The gapping speed employed in the pull away test was 25mm/s
- All measurements performed at 25°C.

## Results and Discussion

Results of the tack testing on the three samples are shown in Figure 2 and Table 1. The Hair wax appears to be the tackiest of the three products with a peak normal force of (-10.32N), followed by the Toothpaste (-7.97N) and the Honey (-6.7N). The gap corresponding with this peak force is related to the critical strain of the material, since accounting for the initial gap, this is how far the material can be deformed before the onset of failure. In this case the Hair wax appears to be the most ductile, reaching a gap of 0.348mm, compared with 0.326mm for the Toothpaste and 0.27mm for the Honey.

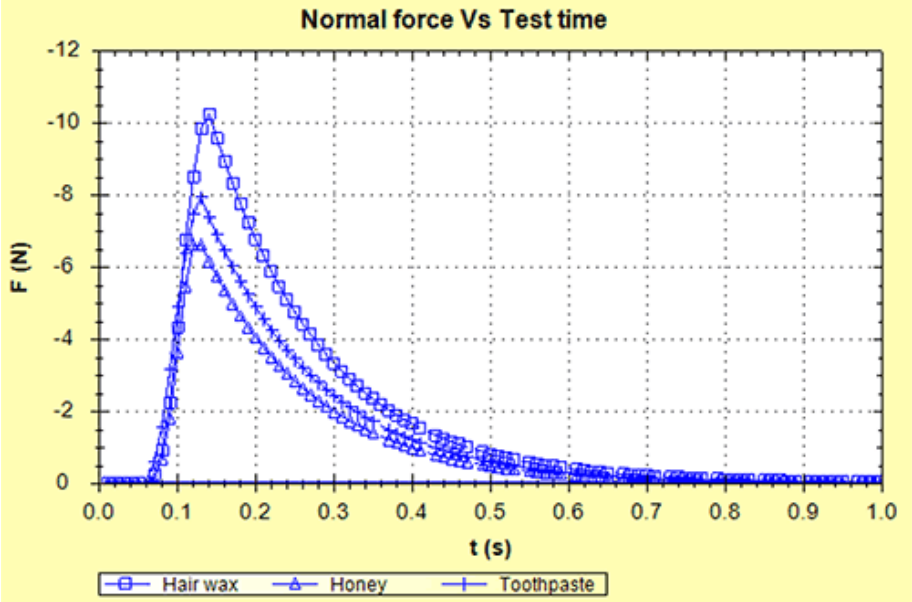


**Figure 2: Normal force-time profiles for Hair wax, Toothpaste and Honey**

In terms of the area under the curves, which relates to adhesive/cohesive strength, the Hair wax appears to be the strongest followed by the Toothpaste and then the Honey. Despite these differences in tack and strength, the force decay profiles are very similar for all three samples and take similar times for the force to decay by 90% of its peak value, in the region of 0.47 seconds for all samples.

**Table 1: Analysis results based on Figure 2 for Hair wax, Toothpaste and Honey**

| Sample Description | Action Name | Time (action)(s) | Normal force(N) | Gap(mm) | Area result |
|---|---|---|---|---|---|
| Hair wax | Area under force time curve (N.s) | | | | 2.557 |
| Hair wax | Time for Force to reduce by 90% of peak | 0.4744 | -0.9868 | | |
| Hair wax | Peak normal force | 0.1388 | -10.32 | 0.3476 | |
| **Sample Description** | **Action Name** | **Time (action)(s)** | **Normal force(N)** | **Gap(mm)** | **Area result** |
| Honey | Area under force time curve (N.s) | | | | 1.536 |
| Honey | Time for Force to reduce by 90% of peak | 0.4646 | -0.6289 | | |
| Honey | Peak normal force | 0.1251 | -6.644 | 0.2704 | |
| **Sample Description** | **Action Name** | **Time (action)(s)** | **Normal force(N)** | **Gap(mm)** | **Area result** |
| Toothpaste | Area under force time curve (N.s) | | | | 1.766 |
| Toothpaste | Time for Force to reduce by 90% of peak | 0.4684 | -0.7540 | | |
| Toothpaste | Peak normal force | 0.1297 | -7.967 | 0.3260 | |

## Conclusion

A Kinexus rotational rheometer can be used to assess the tackiness or cohesive/adhesive properties of a material by monitoring normal force (tension) during a pull away test. In this study such properties were assessed and compared for a Hair wax, Toothpaste and Honey.

## References


- Roberts R.A., Review of Methods for the Measurement of Tack, PAJ1 Report No 5, September 1997.
- ASTM D2979-95, Pressure sensitive tack of adhesives using an inverted probe machine.
- ISO 5833:2002 Implants for surgery - Acrylic resin cement.

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