



NEW INSIGHTS INTO THE INFLUENCE OF ADHESIVE THICKNESS ON TACK AT 20 °C IN HOT MELT PRESSURE SENSITIVE ADHESIVES SUPPORTED ON PAPER

ABSTRACT

Pressure sensitive adhesives (PSAs) are commonly used in packaging and labelling. PSAs are generally supported on different carriers (paper, polyethylene, polypropylene) for producing labels and tapes.

Tack is one of the key properties of PSAs and is influenced by temperature, adhesive thickness, backing nature, measurement equipment (Loop tack, Rolling tack, Probe tack), and measurement conditions (pressure during contact, dwell time, rate of detachment) [1]. Whereas the influence of the most of these parameters have been previously studied, the incidence of the adhesive thickness on tack has been scarcely addressed. The most few studies carried out to date have been made in acrylic PSAs and they have shown that tack increases by increasing PSA thickness [2,3], but some literature evidenced the opposite trend [4]. Furthermore, the influence of the backing of PSAs on tack has not be sufficiently considered yet. Therefore, in this study, the variation of tack at 20 °C with the adhesive thickness (50, 100 and 200 μm) of hot melt PSA supported on paper (PSA/Paper) was studied. The tack was measured by using the probe tack method. As reference, non-supported bulk hot melt PSA of 200 μm thickness (bulk PSA) was prepared. In order to correlate the variation of tack with the changes in surface energy and chemistry on the adhesive surfaces of PSA/Paper, they were analyzed by water and di-iodomethane contact angles, and X-ray photoelectron spectroscopy (XPS) and Raman spectroscopy respectively.

The tack at 20 °C (taken at the maxima of the stress vs strain curves) of PSA/paper tapes decreases by increasing the adhesive thickness. Furthermore, for the same adhesive thickness (200 μm), the tack at 20 °C of PSA/paper tapes decreases significantly with respect to the one on bulk PSA (Figure 1). The shape of the tack curves at 20 °C of PSA/Paper varies with the adhesive thickness, and the maximum strain becomes larger with the increase of adhesive thickness (Figure 1).

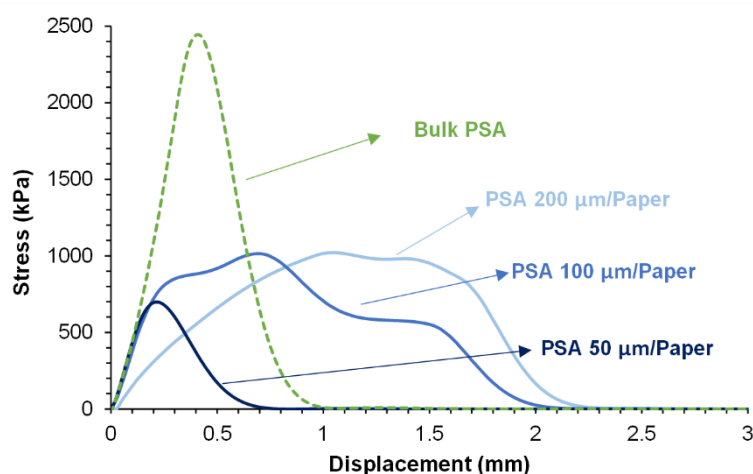


Figure 1:

Variation of stress vs displacement at 20 °C of bulk PSA and PSA/paper tapes with different PSA thickness.

These variations can be ascribed to the balance between non-linear variation of the strain rate and the different orientation of the polymer chains located at both the probe-PSA surface and PSA-paper backing interfaces.

The water contact angle value at 20 °C on PSA adhesive decreases from 94° (bulk PSA) to 91° when supported on paper (PSA-200 µm/Paper), and the contact angle values of PSA/Paper vary slightly (88-91°) with the adhesive thickness and they are more similar to the one on paper (91°). The lower contact angle values on PSA/Paper can be ascribed to increased polarity with respect to the paper and the bulk PSA. In fact, the Raman spectra of PSA/paper with different adhesive thickness show different intensities of C=O (1735 cm⁻¹) and C-O-C (1086-1087 cm⁻¹) stretching bands (Figure 2). The ratio of the intensities of those bands ($I_{C-O-C}/I_{C=O}$) is lower in PSA/paper tapes with adhesive thicknesses of 100 and 200 µm than in bulk PSA, but higher in PSA/paper tape with adhesive thicknesses of 50 µm (Figure 3).

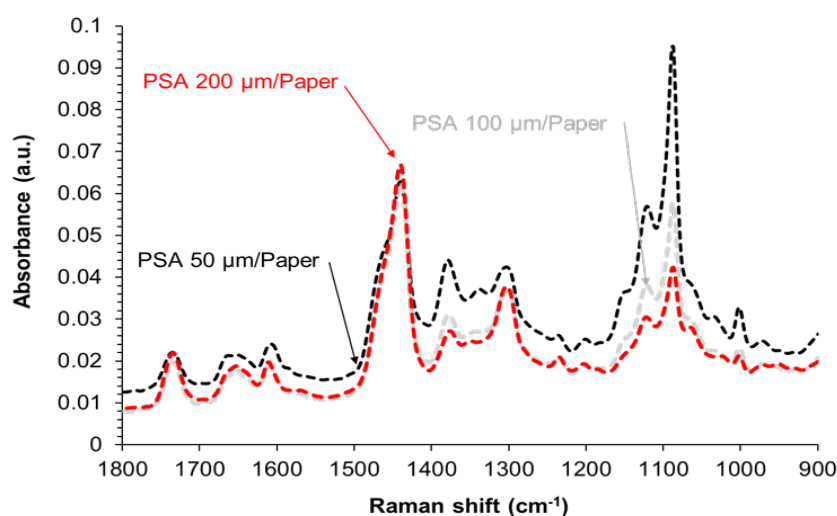


Figure 2.

Raman spectra of PSA/paper tapes with different thickness.

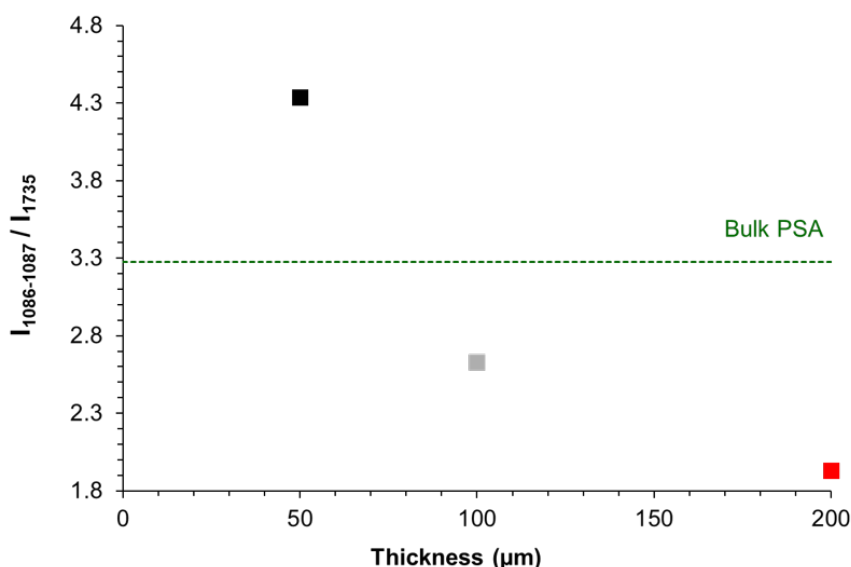


Figure 3:

Variation of the ratio of intensities of C-O (1086-1087 cm⁻¹) and C=O (1735 cm⁻¹) vs adhesive thickness of bulk PSA and PSA/paper tapes with different adhesive thickness.

In summary, the paper backing reduces the tack at 20 °C of hot melt PSA due to higher surface polarity caused by enriched oxygen species on PSA surface. Furthermore, the decrease of the adhesive thickness in PSA/paper tapes increases the polar component of the surface energy and reduces the dispersive component of the surface energy, more noticeably in PSA/paper tapes with adhesive thickness between 50 and 100 µm.

References

- [1] Shull, K.R.; Creton C. Deformation behavior of thin, compliant layers under tensile loading conditions. *J Polym Sci B: Polym Phys*. 2004: 42(22).4023–4043.
<https://doi.org/10.1002/polb.20258>
- [2] Benedek, I. Pressure-sensitive adhesives and applications: Rheology of pressure sensitive adhesives. Dekker, New York, 2004.
- [3] Doi, M.; Yamaguchi, T. Analytical solution for the deformation of pressure sensitive adhesives confined between two rigid plates. *J Non-Newtonian Fluid Mech*. 2007: 145(1), 52–56. <https://doi.org/10.1016/j.jnnfm.2006.12.006>
- [4] Michaelis, M.; Leopold, C.S. A measurement system analysis with design of experiments: Investigation of the adhesion performance of a pressure sensitive adhesive with the probe tack test. *Int J Pharmaceutics*. 2015: 496(2), 448–456.
<https://doi.org/10.1016/j.ijpharm.2015.09.061>