INFLUENCE OF IBUPROFEN CONTENT ON THE ADHESION PROPERTIES AND RHEOLOGICAL BEHAVIOR OF AN ACRYLIC PRESSURE SENSITIVE ADHESIVE

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INTRODUCTION

Adhesion of transdermal systems to the skin is a critical factor directly related to cutaneous drug penetration and thus therapeutic effect.
The factors which are essential in characterizing the properties of Pressure Sensitive Adhesives (PSAs) comprise tack, peel adhesion, and shear strength (Fig. 1) [1].

Fig. 1: Characteristics of a pressure sensitive adhesive

The adhesive properties are determined via static measurements and can be correlated with the results of a frequency dependent experiment (Fig. 2) [2].

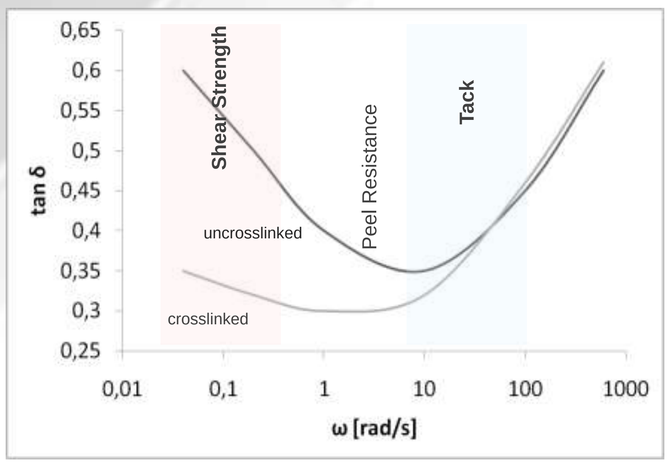

Fig. 2: Correlation between frequency dependent measurements and PSA properties

In the present study the in vitro adhesion properties of DuroTak®-387-2051, a solvent-based acrylic PSA, were compared to the rheological behavior at increasing ibuprofen content.

MATERIALS

Model drug: Ibuprofen (BASF, Ludwigshafen, Germany)
PSA: DuroTak® 87-2051 (Henkel, Bridgewater, NJ, USA)
Release Liner: Scotchpak® 1020 (3M, Neuss, Germany)
Backing Membrane: Platilon® U073 PE (Epurex Films GmbH & Co.KG, Bomlitz, Germany)

METHODS

Rheology

Samples of DuroTak® 87-2051 with increasing ibuprofen content were prepared for rheological analysis by lamination of multiple layers of 0.2 mm dry adhesive film leading to a final thickness of 1 mm.
Temperature sweep and frequency sweep experiments were performed with a Rheometrics Dynamic Analyzer II (Rheometrics Inc.) equipped with a 25 mm parallel plate geometry and a convection oven. Frequency sweeps were run at +25 and +32 °C followed by a combined temperature frequency sweep from -60 to +200 ºC (5 °C steps) at 0.1 to 100 rad/s. Linear viscoelastic behavior was confirmed by a strain test at 100 rad/s.

In vitro Adhesion Experiments

For in vitro adhesion experiments test patches consisting of backing membrane and adhesive matrix (55 ± 10 µm) were prepared.
These patches were analyzed by standard test methods of the Pressure Sensitive Tape Council (PSTC) such as Peel Adhesion (PSTC-101, Fig. 3), Tack Rolling Ball (PSTC-6, Fig. 4) and Shear Adhesion (PSTC-107, Fig. 5) at 25 and 32 °C.

Fig. 3: 180° Peel Adhesion

Fig. 4: Rolling ball tack

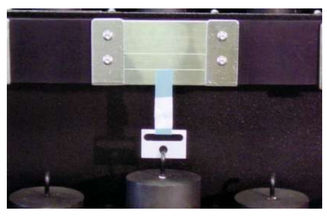

Fig. 5: Shear adhesion

RESULTS & DISCUSSION

Tan δ values were obtained from temperature sweeps and frequency sweeps (Figs. 6 and 7).

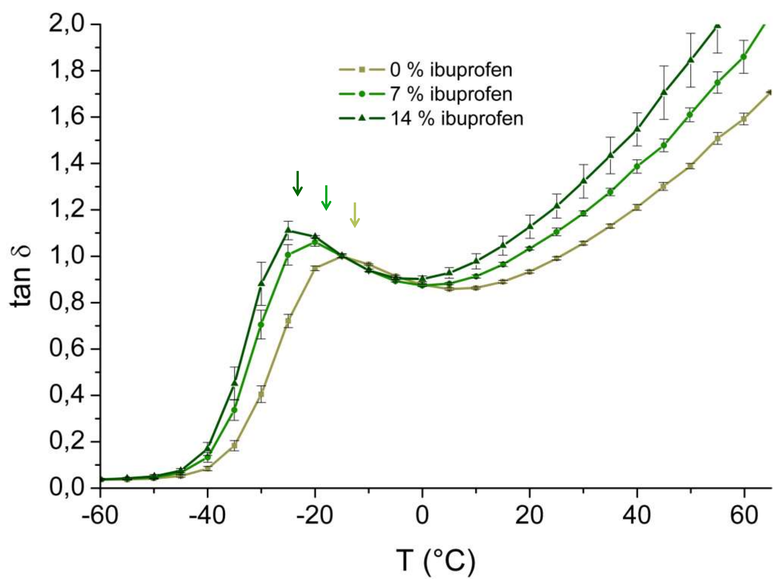

Fig. 6: Temperature sweeps of the PSA from -60 to +200˚C at 10 rad/s with 1 % strain and increasing drug content (n = 3, means ± SD)

From the plots a decrease of the dynamic Tg with increasing drug content could be observed.

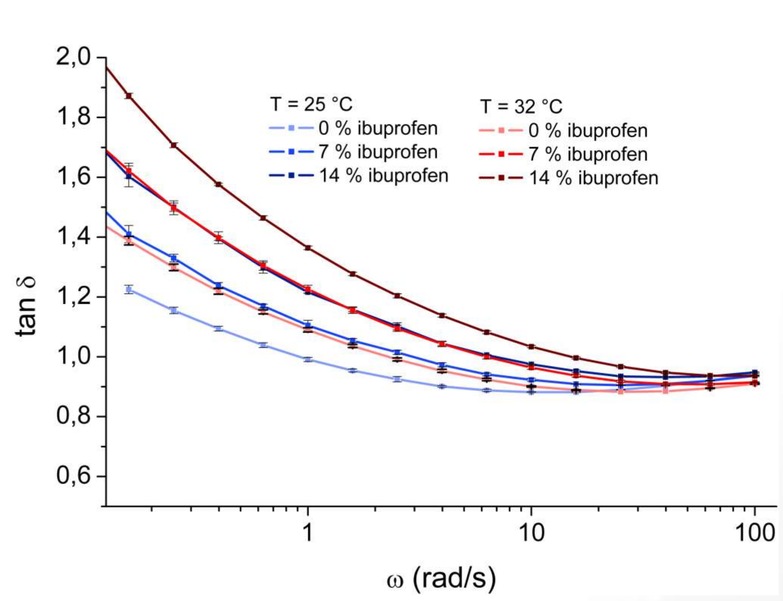

Fig. 7: Frequency Sweeps of the PSA at 25 and 32 ˚C with 1 % strain and increasing drug content (n = 3, means ± SD)

With increasing drug content a frequency and temperature dependent increase of tan δ became apparent.

3D plots show a decrease of the dynamic Tg with increasing drug content at all investigated frequencies (Fig. 8).
Both the minimum of the tan δ curves and the slope were found to be shifted to higher values with increasing drug content at all investigated frequencies.

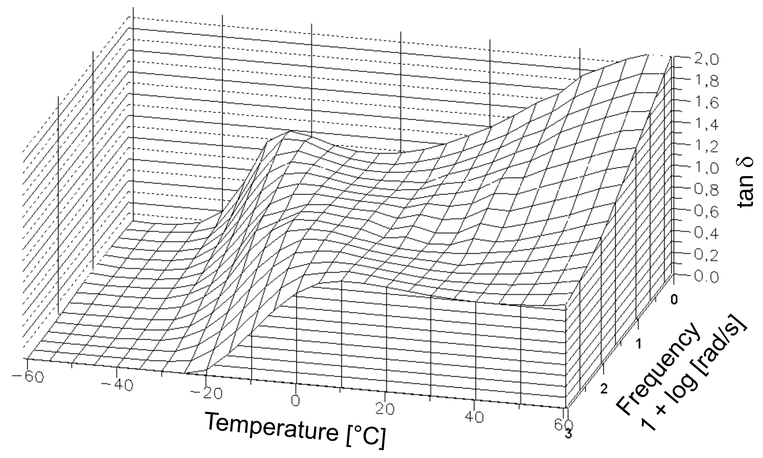

Fig. 8: 3D plot of the PSA from -60 to +200 ˚C and from 0.1 to 100 rad/s with 1 % strain and 0 % ibuprofen content, (n = 3, means)

Adhesion experiments resulted in a decrease in shear adhesion and an increase in tack (Fig. 9).
Peel adhesion was not measurable due to cohesion failure.

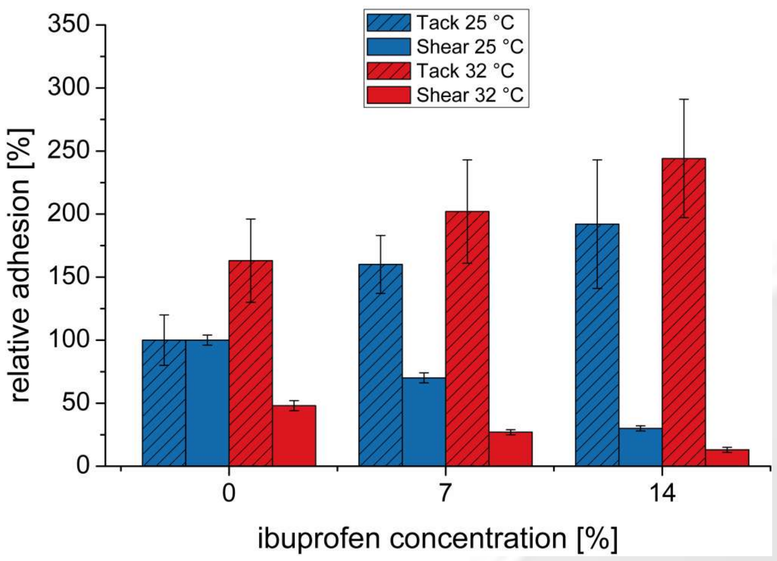

Fig. 9: In vitro adhesion displayed as tack and shear strength; samples measured at 25 ˚C with 0 % drug content served as reference (= 100 %) (n = 5, means ± SD)

CONCLUSION

- Rheological measurements are suitable to detect and quantify changes in adhesion properties.
- Addition of ibuprofen as well as a temperature increase lead to fluidization of the adhesive.
- Addition of ibuprofen causes a shift of the dynamic Tg to lower temperatures.

ACKNOWLEDGEMENTS

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REFERENCES

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[2] Brummer, R. et al., Appl. Rheol. 7, 173-178 (1997)

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