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ADVANCED RHEOMETRY TOOLS FOR ADHESIVE CHARACTERIZATION

Rheology is a key method for analyzing adhesives. It provides information about their visco-elastic properties and the effects of additives on attributes such as flow behavior, elasticity, consistency, cure time, adhesion, film thickness and appearance. This versatile approach not only tracks the entire curing process of different adhesive types, but also evaluates the mechanical behavior of the resulting solid product under various environmental conditions. Combining a modern rheometer with specially designed accessories, such as those for humidity control or Raman spectroscopy, reveals additional information that is essential for development, processing, usability and service life of adhesives.

In particular, the integration of Raman spectroscopy with rheological analysis facilitates real-time monitoring of the curing process and provides direct and real-time insights about chemical reactions occurring over time, with temperature, at different humidities, or combinations thereof. Raman spectra provide a unique fingerprint of the functional groups and chemical backbone structure of the adhesives, and give information on reaction rate, pot life and cure times, or the presence of intermediate or by-product species.

In this study, simultaneous Rheo-Raman measurements with intermittent UV irradiation on UV-curable adhesives are presented. Humidity is known to have a significant effect not only on the cure kinetics but also on the mechanical properties of the cured adhesive, to be determined with Dynamic Mechanical Analysis (DMA). Therefore, it is essential to investigate UV-induced curing reactions at different humidity conditions, and to evaluate the creep behavior of solid adhesives.

In addition, measuring Poisson's ratio with an axial-torsional DMA (based on the indirect method [1]) provides deeper insight into bond behavior, especially regarding the interface between different materials. Differences in the lateral to longitudinal deformation ratio, indicated by the Poisson's ratio, may affect bond strength and bond durability. This can lead to stress concentrations and premature failure. Understanding the Poisson's ratio of adhesives and their extensional properties in general is therefore critical for optimal product design and performance. Our contribution provides a comprehensive overview of possible method combinations with Rheometry, their added value and names specific application examples.

References

[1] Rodríguez Agudo, J. A., Haeberle, J., Mueller-Pabel, M., Troiss, A., Shetty. A., Kaschta, J., Giehl, C. Characterization of the temperature and frequency dependency of the complex Poisson's ratio using a novel combined torsional-axial rheometer *J. Rheol.* 67, 1221–1250 (2023).