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EZRT

FRAUNHOFER INSTITUTE FOR INTEGRATED CIRCUITS IIS
DEVELOPMENT CENTER X-RAY TECHNOLOGY EZRT

POLYMER-PROFILER

MOBILE MAGNETIC RESONANCE PROFILING FOR THE LABORATORY AND THE PRODUCTION LINE

Polymers, such as plastics, adhesives and sealants as well as other magnetic resonance visible materials, can be analyzed and characterized non-destructively by the Fraunhofer EZRT Polymer-Profiler Software. The use of a dedicated mobile MRI system developed by Pure Devices GmbH ensures an outstanding sensitivity for this task. The data is acquired using magnetic fields and pulsed radio frequency (RF). It is then processed and displayed as plots by the software. Any material change caused by e.g. chemical, thermal or aging processes has an influence on the MR data, enabling the user to detect this change and take prompt measures to assure the required quality or to regulate underlying processes.

MEASUREMENT PRINCIPLE RELAXOMETRY

Relaxometry acquires the fundamental MR relaxation times T1, T2 and T2*. These material characteristic parameters are measured quantitatively by dedicated MR sequences and are plotted as parameter maps. These so called fingerprints show patterns which are characteristic for the examined materials.

The data acquisition starts about 5 µs after the first RF excitation and has a time resolution of 8 ns for T2* and of 20 µs for T2. In general, these unprecendentedly short scan times increase not only the detection accuracy of the fast decaying relaxation time course but they also significantly improve the distinguishability of the complex individual relaxation decays. Access to early measurement points of fast decaying exponential relaxations, as in polymers, is crucial for the quality of the analysis.

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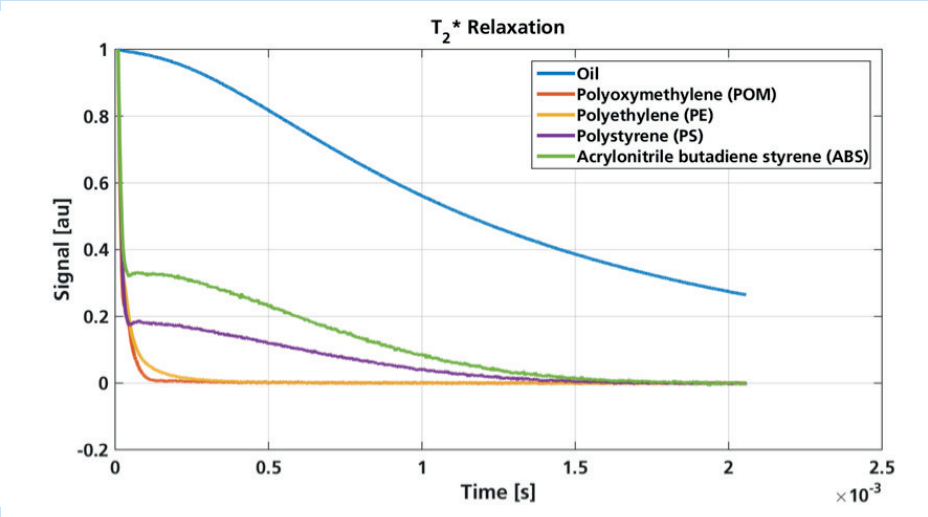
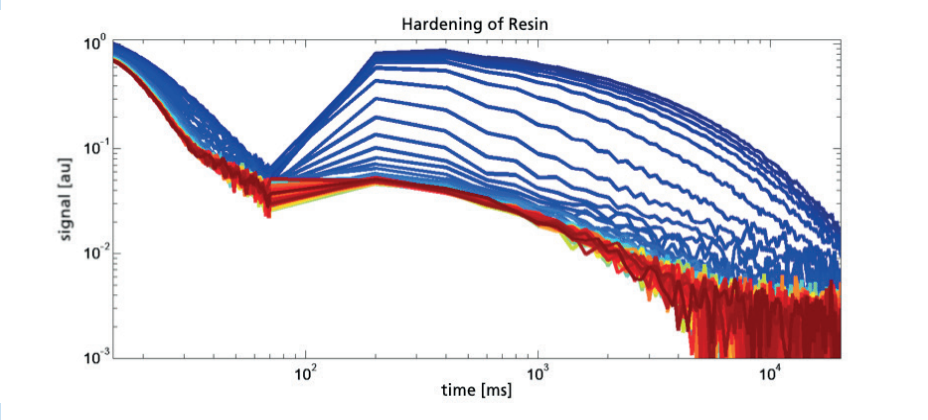
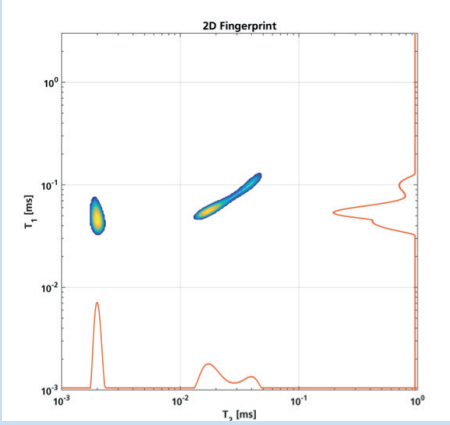


Characteristic relaxation curves for various materials.



Change of relaxation curves from a resin hardening process. Each curve, from dark blue to red, represents a time point during the transition from liquid to cured.



The 2D-fingerprint spectrum depicts the correlation of two relaxation times. This improves the significance of the measured characteristic material information, whereas the uncorrelated single relaxation spectra only provide the information concerning the projections (see orange profiles along the axes at the bottom and on the right side).

Relaxometry is able to non-destructively monitor small and fast changes such as those which can be observed during hardening or drying processes. Signal variations are registered almost in real time to assure quality or to control inline processes such as extrusion.
For the characterization of materials, the Polymer-Profiler Software also provides the generation of a 2D-fingerprint spectrum that correlates the specific T1 and T2 relaxation times of the material and creates a unique detailed map of its attributes. This map can be used to unequivocally identify materials or to monitor changes over time.

SCOPE OF APPLICATION

The Polymer-Profiler can be used in numerous areas in which the properties of plastics, adhesives and sealants must be monitored. In the domain of material research and development, the 2D-fingerprint maps are a powerful tool for monitoring and observing the specific properties of materials.
The scope of application includes the monitoring of aging processes in polymers and their impact on maintenance or durability. The hardening processes of adhesives and sealants can be characterized and optimized by monitoring under varying ambient conditions such as temperature and humidity.

This enables companies in the manufacturing industry to inspect the quality of adhesive- and sealant components and to monitor inter-batch variations straight after delivery from sub-suppliers.
Another application is the detection and sorting of polymers in the recycling industry. Using the Polymer-Profiler it is possible to identify the material independent of its color or surface treatment. The Polymer-Profiler allows the differentiation of polymers which is not possible when using conventional, established techniques such as infrared detection.