Dielectric Polarization Measurement in QC of PU Formulations

Messtechnik GmbH

ERLAND E. HOFMANN
Format Messtechnik GmbH
D-76187 Karlsruhe
Germany

D. JEFFREY GROSS
EuroTech Distributors
Northfield, Ohio 44067
USA

- Curing monitoring of PU formulations
- Valuable information additional to foam rise height, rise pressure, temperature and loss of mass
- Pot Life determination of CASE formulations
- Master curves for quality control testing

The traditional method for characterizing PU foam samples is to determine the rise height or rise profile of foam samples in a cup or in a test mold. Non foaming PU formulations are characterized by their pot life, which is determined by measuring the viscosity. A new and recent development in this field is the use of sensors that monitor the dielectric polarization of the reacting system (Fig. 1). The dielectric polarization gives information related to the state of cure of the polyurethane molecules.

Foam application:

For any kind of foam the state of cure can be evaluated from the steady decrease of the dielectric polarization (Fig. 2) after maximum rise before the system finally gives constant reading at a very low level. For reproducible dielectric polarization measurement, the foam must be in close contact with the sensor. This is achieved by positioning the sensor at the bottom of the expansion container. In order to simulate process near test conditions, the sensor surface can be heated up to any process relevant temperature.

The polarization signal of a PU foam systems is also influenced by the foam density, which decreases during the expansion (rise) phase. However, as shown in Fig. 3, although the signal falls dramatically in the first phase of the foaming process, there is often a sharp, temperature dependant increase in the dielectric polarization during the rise phase. This is attributed to the dipoles of the intermediate polyurea, which is formed by the gas generation reaction. For quality control, the generation of master curves is supported.

CASE application:

The dielectric polarization measurement technique can also be used for non foaming CASE formulations. The pot life and curing monitor device SubCASE (Fig. 4) combines a temperature controlled dielectric polarization sensor with two temperature transducers.

Polarization data is obtained from the very beginning of the chemical reaction until the end of the curing process. As an example, measurements using SubCASE® have been made with a transparent, fast curing polyurethane cast skin formulation for wooden applications (Fig. 5).

The new measurement technology gives detailed insight into the reaction process of PU-based systems. The polarization can be measured in combination with other physical parameters during the chemical reaction, making it suitable for QC testing.

www.format-messtechnik.com

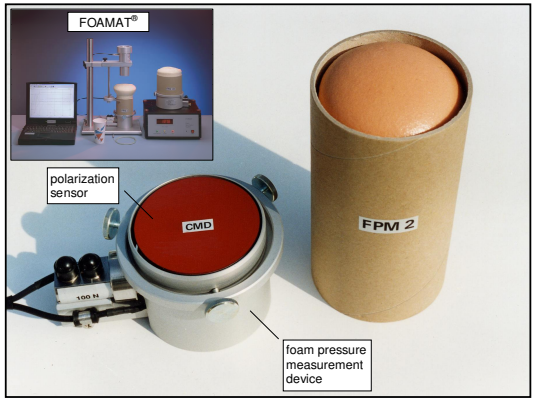

Fig. 1: The polarization sensor CMD2, integrated into the foam pressure measurement device FPM2, measures the dielectric polarization of the foam in combination with rise profile and temperature.

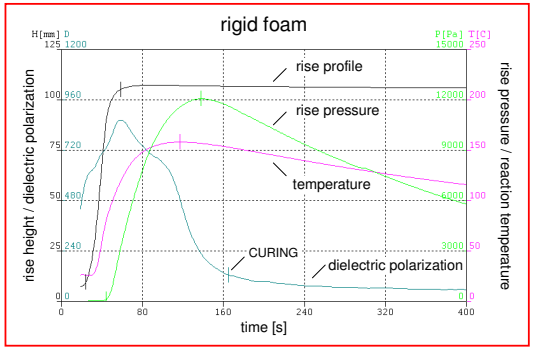

Fig. 2: The experimental data for rise height, dielectric polarization, rise pressure and temperature of a rigid foam formulation. The dielectric polarization was measured at low frequency, revealing perfectly the curing of the formulation.

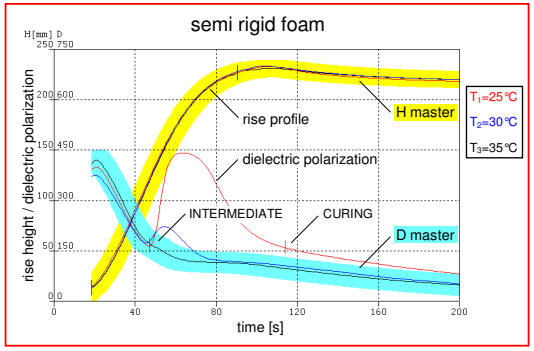

Fig. 3: The figure shows the variation of the dielectric polarization of a semi rigid formulation at three different temperatures. The H master and the D master are generated by the software FOAM for QC purposes.

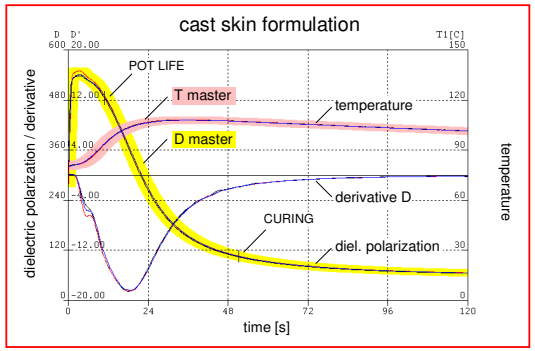

Fig. 5: Three dielectric polarization and temperature measurements of a transparent, fast curing cast skin formulation, which is used for fine wood decoration. The data show perfect reproducibility.

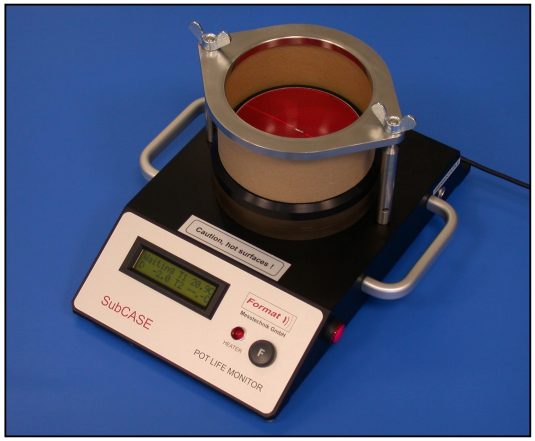

Fig. 4: The temperature controlled curing monitor device SubCASE® measures the pot life and the curing of Coatings, Adhesives, Sealants and Elastomers (CASE).