

## Materials testing at a high level

The ThermoPlastic composites Research Center TPRC in the Netherlands, is a research and development center that focuses on thermoplastic composites for a broad range of end use markets, under the guidance of industrial companies who are members of TPRC. Thermoplastic composites are important materials for many contemporary high end applications in transport, industry and healthcare. TPRC is primarily executing joint development projects on new thermoplastic composite technologies and applications. In these joint projects TPRC takes into account materials, processing and design aspects. Next to the joint technology projects, TPRC also executes specific developments for its members or third parties. MKF 115 environmental simulation cham-

bers and VD 115 vacuum drying ovens from BINDER are used in testing the various materials.

### Humidity attacks polymer composites

Most polymer composites are sensitive to moisture. The mechanical properties of the polymer matrix change depending on the moisture content and the temperature. How sensitive a polymer is for moisture depends on its molecular structure and for instance the presence of polar groups. Moisture leads to a decrease of stiffness and strength, but may also lead to an increase of fracture toughness and ductility. This is valid for thermoset as well as thermoplastic polymers. Usually glass and carbon fibers become a coating to improve the bonding between the fibers

### Requirements

- ▶ Testing of thermoplastic composites
- ▶ Designation of humidity
- ▶ Reliable results to define knockdown factors
- ▶ Gentle circulation of air with homogeneous climate conditions
- ▶ Reliable stress tests
- ▶ Easy handling
- ▶ High quality standards

### BINDER Solutions

- ▶ Environmental simulation chamber MKF115
- ▶ Precise temperature control
- ▶ Large temperature range -40 °C to 180 °C
- ▶ Humidity range 10 — 98% r.H.
- ▶ Control accessible from the front
- ▶ Vacuum drying oven VD 115
- ▶ Homogeneous climate conditions APT.line™
- ▶ Patented expansion rack technology
- ▶ Homogeneous sample trying
- ▶ Fast, condensation-free drying process
- ▶ Direct transfer of heat to the specimens due to thermal conducting plates



and the matrix, thus improving the mechanical performance. These so-called sizings usually are thermoset polymers of some tenth of a micrometer thickness. Next to the polymer matrix, the sizing is attacked by moisture as well.

### Climate testing explores knockdown factors

In order to know the knock-down factors for the design process usually a number of tests are performed under different conditions. This involves for instance cold temperature dry, room temperature dry and hot wet testing. BINDER climate chambers and vacuum ovens are employed to condition the coupons to the right moisture level. In the case of wet

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*Bert Rietman, Senior research associate at TPRC*

testing conditions the coupons are fully saturated, whereas in dry conditions the coupons are completely free of moisture. The wide temperature range from -40 to 180 °C and humidity range from 10 – 98% of the MKF 115 environmental simulation chamber are of particular importance for these variable applications. Just as important is use of the VD 115 vacuum drying oven from BINDER, which reduces the moisture content of the materials as required. "We



▲ Designation of knockdown factors

can rely on BINDER chambers 100% as any failure would mean a delay of months for us," explains Bert Rietman, Laboratory Manager at TPRC, about their requirements. These tests are a standard in aerospace industry for a long time. Similar tests are used for polymers and polymer composites in the automotive industry nowadays.

### Ease of use and stable test conditions

The driving force for moisture uptake is diffusion. Based on the moisture uptake curves, which are measured using an analytical balance, and the time needed to obtain saturation, the diffusion coefficients can be identified. In the case of so-called Fickian diffusion a relatively simple mathematical expression describes the evolution of the moisture concentration. Usually, however, this is not the case, which leads to the conclusion that other mechanisms, as for instance the aforementioned mois-

ture transport along the interfaces, play a role. Together with its partners, TPRC is investigating the mechanisms that play a role in moisture uptake and the influence of saturation level on the mechanical properties of the product, with the final goal of identifying reliable knock-down factors with relative ease. The environmental simulation chambers and drying ovens from BINDER make it possible to precisely determine these processes. APT.line™ in the inner chamber means even air circulation, which ensures homogeneous climate conditions. The research and development center particularly values how easy the chambers are to use, which facilitates the daily work of the staff. TPRC also values the low noise level of 62 dB. Among others, the company uses some of their own proprietary standards, in which the ASTM and ISO standards are taken into account for testing in BINDER chambers.

### Advantage

- ▶ BINDER APT.line™
- ▶ BINDER Cross-Flow Prinzip
- ▶ User-friendly LCD screen
- ▶ Easy-to-read menu guide
- ▶ Made in Germany

### Areas of application

- ▶ Automotive
- ▶ Electronics / Semiconductor Industry
- ▶ Plastic Industry
- ▶ Aerospace / Defence Industry
- ▶ Surface Technology



▲ Vacuum drying oven VD115

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