Creep of GMT

The following creep measurements were carried out on GMT at room temperature and 100°C by NPL (National Physics Laboratory, UK) and were presented in a test report. The material (GM 40 PP SH) was a chopped fiber GMT (fiber length 50 mm) with needled mats and a PP-matrix.

In the figures below, there are creep curves given both as the pure strain measurements (Figures 1 and 3) and the relative creep modulus (the modulus divided by the modulus after 0 seconds), Figures 2 and 4 as a function of time in seconds. This is given in Figure 1 and 2 at 23°C (73 F) and in Figures 3 and 4 at 100°C (212 F).

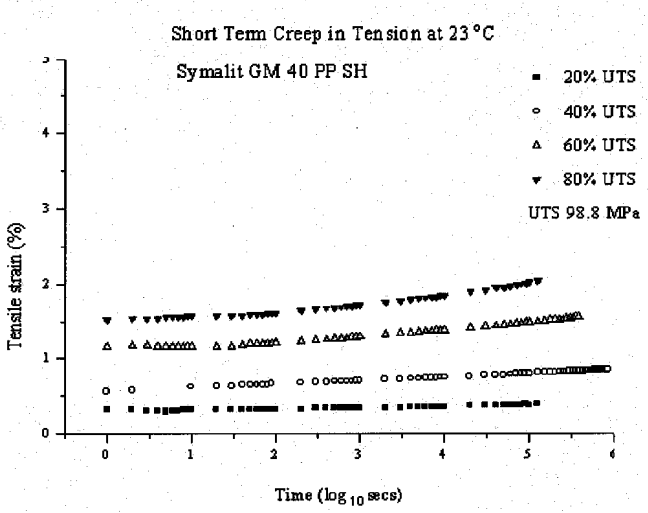

Figure 1. Creep of GMT at room temperature, strain of time and load.

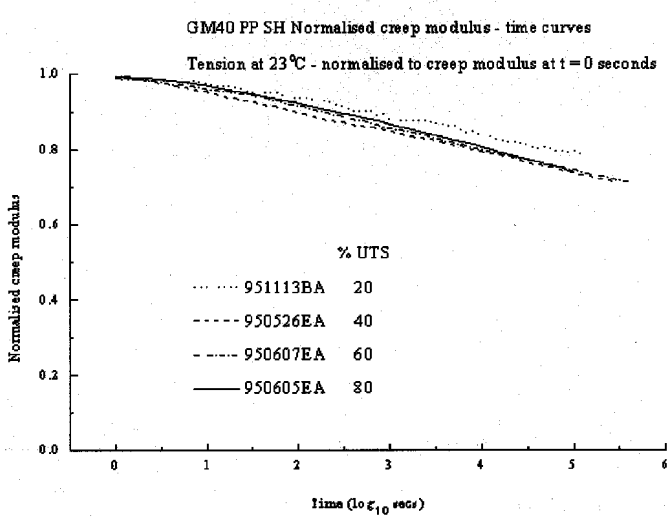

Figure 2. Creep of GMT at room temperature, normalized modulus of time and load.

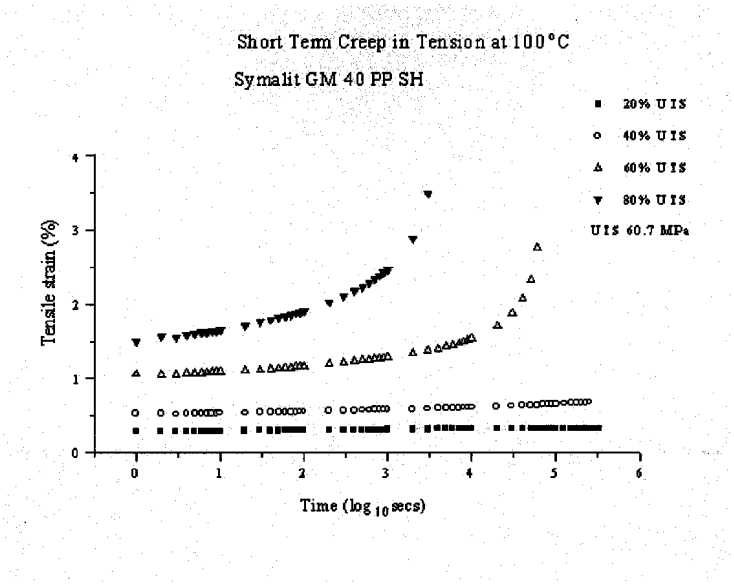

Figure 3. Creep of GMT at 100°C, strain of time and load.

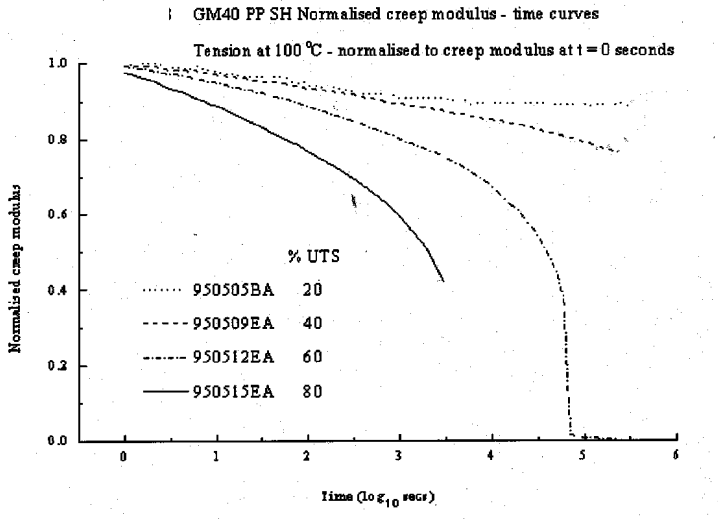

Figure 4. Creep of GMT at 100°C, normalized modulus of time and load

Assumptions for validity

In the linear region, which is 0-80% of the ultimate tensile strength, UTS, at room temperature and up to 20 - 40% of UTS at 100°C (212 F), it is reasonable to assume that the same relative creep modulus is valid for all fiber contents.

This assumption is supported by the results in "Dynamical Mechanical Analysis of Glass-Mat-Reinforced Polypropylene (GMT-PP)" by Schledjewski and Karger-Kocsis, published in Journal of Thermoplastic composite materials, Vol. 7 1994, where they investigated the temperature dependence of the stiffness.

Interpretation

For any PP-GMT with a fiber content between 20 and 50% glass fibers, this measured curve for GMT with 40% glass fibers can be used. The y-axis of the (b) figures in Figure 1 and 2 only has to be multiplied with the "static" stiffness of the material. The stress level related to each curve is given as a percentage of the materials ultimate tensile strength, which is measured in the "static“ test.

Use
These curves can be used for any GMT to extrapolate the creep behavior from a static bending or tensile test.

What about temperatures between 20°C and 100°C?
Up to 80°C, it is reasonable to assume that the material will behave as in Figure 1 rather than as in Figure 2, the motivation is that the "secondary" glass transition temperature for the PP lies at approx. 80° C, above this temperature range, the material is much more prone to creep, below it is less so.

Data?
Every measured data point can be given out for further analysis such as numerical modeling with a Prony series or similar models.

Approximate creep rule
At 1000 hours and within limited load levels and temperatures, the creep modulus will drop to about two thirds of its "static" value at the given temperature.