Creep prediction for fiber reinforced polymers

In this section, we discuss about the prediction of long term deformations due to secondary creep for fiber reinforced polymers.

The use of a DIGIMAT viscoelastic of viscoplastic model has been investigated to predict the creep response of different grades, including, for instance, the AMODEL AXS-1655. This approach is based on the measurement of long term creep curves (typically 1500 hours) on the fiber filled polymer, in different fiber orientations and at different stress levels. As this method can lead to a rather important experimental cost and duration, alternative approaches are studied to reduce the amount of physical testing.

A first possibility is to consider the so-called DIGIMAT "SREP" (Strain Rate dependent Elasto-Plastic) approach which implies to perform tensile tests only but at different strain rates (from 1E-3/s to 1E-6/s for instance) and to use extrapolation methods to derive the curves at really low strain rates (down to 1E-12/s). This methodology, still being applied at the fiber reinforced polymer level, the data must be generated in different fiber orientations and are to be considered for a given fiber content.

- The application of the standard viscoplastic model and the SREP approach is illustrated, for the Amodel AXS-1655, in the document available here .

Then, we can also go one step further by starting from properties generated on the neat resin only and then using a DIGIMAT FE (Finite Element) approach to compute the response of the fiber filled polymer by numerically introducing the contribution of the fiber content. The data on the neat resin can consist of measured creep curves but, ideally, a model as the EGP model can be used to model the creep curves of the neat resin starting from shorter term tests (compression tests at different strain rates). Considering the UDEL GF-120 grade, we have been able to implement this method and to compare its performances to the standard viscoplastic model and to the SREP approach.

- The simulation report illustrating the different approaches to model the creep behavior of fiber filled polymers, applied to the UDEL GF-120, is accessible here.