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THERMO-VISCO-ELASTIC MODEL FOR ORGANIC MATRIX COMPOSITE MATERIALS ON A LARGE RANGE OF STRAIN RATES AND TEMPERATURES - APPLICATION TO T700GC/M21

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Due to change in regulation to meet the challenge of a greener world, organic matrix composite materials are nowadays widely used in transportation industry to reduce structural weight. During the life cycle of an aircraft, structural parts are submitted to various mechanical and thermal loadings. As organic matrix composite materials are known to be rate and temperature dependent [1], designers have to take into account low to high strain rates mechanical loadings under low to ambient environmental temperatures in the sizing loop. To complete this task, a thermo-visco-elastic spectral model is proposed, identified and validated on a large range of strain rates, from creep to dynamic loadings under low to ambient environmental temperatures for the T700GC/M21 composite material.

This model is based on a spectral description of the viscous mechanisms at the mesoscopic scale which has been proven to be representative of the laminate behaviour on a large range of strain rates at ambient temperature [2]. In this study, the enrichment of the model regarding temperature effects is proposed. Different characterisation tests have been performed on the laminate and/or on the M21 resin (for physical justification). First, dynamic tensile tests under various environmental temperatures have been performed on $[\pm 45^o]_s$ specimens to characterise the strain rate and temperature dependencies of the T700GC/M21. Dynamic Mechanical Analysis (DMA) has been performed on the M21 resin to specificaly characterise the viscoelastic behaviour of the matrix. Experimental results have been used to proposed a physically based enrichment of the model thanks to the time-temperature superposition principle. Only one parameter has been added to the spectral model to describe the temperature dependency from -100^{o}C to 20^{o}C. This parameter is influencing the viscous spectrum, as shown in Figure 1, which leads to a variable activation of the viscous mechanisms with respect to the temperature.

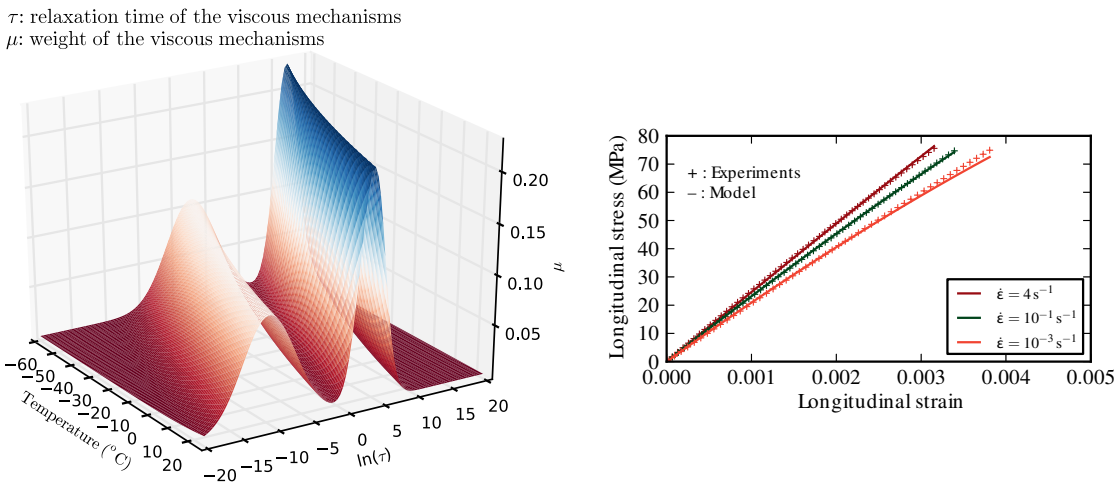

Figure 1: Representation of the temperature dependent viscous spectrum identified on T700GC/M21 dynamic tensile tests (on the left hand side) and comparison of the stress-strain curves between experiments (dots) and the identified model (lines) for various strain rates with an environmental temperature of -100^{o}C (on the right hand side)

The model identification has been reach thanks to dynamic tensile tests results (red curves on Figure 1) and it finally proves to be representative and predictive on a large range of strain rates and temperatures from -100^{o}C to 20^{o}C.

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