

Damage development during thermal ageing in carbon fibre reinforced polyimide composites

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Carbon fibre reinforced thermosetting polyimide (CFPI) composites are lightweight materials with glass transition temperature (T_g) in the range 380-466 °C and good ability to withstand thermal degradation [1]. However, during prolonged exposures to elevated temperature, and in the presence of oxygen in the atmosphere, CFPI materials experience degradation, which results in loss of mechanical properties and weight, and formation of defects [2,3].

A recent study, [3], has investigated the effect of weave pattern and ply thickness on both weight loss and damage development during 500 hours oxidative ageing of CFPI, Figure 1. The study also highlighted the importance of initial porosity on the weight loss and degradation behaviour of the composite.

The weight loss pattern of both composite types was marked by two main regions. An initial, fast desorption of components from the matrix, and subsequent, slower weight loss, mainly attributed to thermal and thermal oxidative degradation. The initial desorption stage was modelled, based on Fickian diffusion.

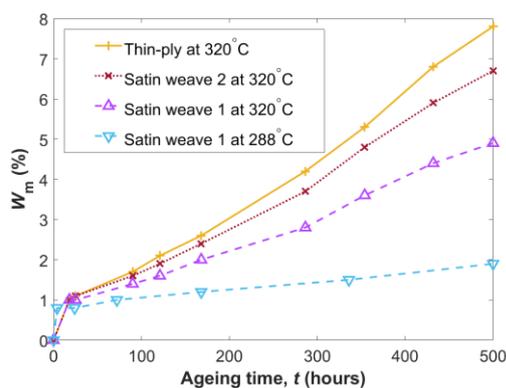


Figure 1: Long term ageing in air of satin weave and thin-ply CFPI. Satin weave 2 had a high initial amount of porosity. The higher weight loss of thin-ply was also attributed to initial defects/porosity.

X-ray computed microtomography was used to study in 3D the degradation development in the samples, Figure 2. It was shown that the two material systems formed cracks in different manners. The satin weave developed crack networks, propagating from the

surface into the sample and consisting of multiple cracks, pores and delaminations, while the thin-ply exhibited single delaminations on the free edges of the specimens.

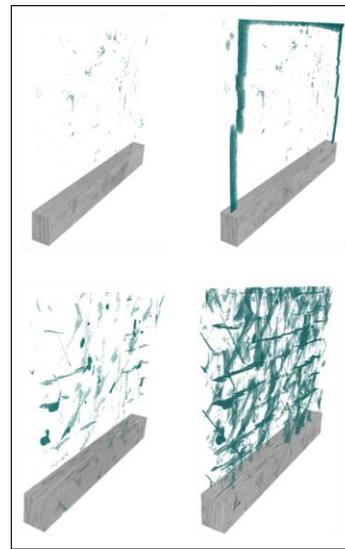


Figure 2: Defects outlined through segmentation. Top: Thin-ply before (left) and after (right) ageing. Bottom: Satin weave before and after ageing. Ageing was performed at 320 °C in air for 500 hours.

References

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