

INTELLIGENT PROCESS MONITORING IN THE MANUFACTURING OF FML STRUCTURES

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Fibre Metal Laminates (FML) of exceptional performance have been used already in commercial aircrafts with the aim to combine the advantages of metals and reinforced plastics in a laminate structure. In order to ensure the optimal processing of the reinforced adhesive, an intelligent process monitoring system has been developed for the in-situ process monitoring of the manufacturing process within an autoclave. The simultaneous measurement of the resin's temperature and electrical resistance allow for the real-time prediction of the viscosity, the degree of cure and the T_g . The curing of the polymer adhesive was modelled in the lab and its electrical properties were correlated to its Glass Transition temperature. Then the Online Resin State (ORS) was developed to provide online the evolution of the T_g . Finally, the cure monitoring system for four sensors was installed in DLR Stade autoclave and a first representative trial was executed. As can be seen in fig.1, each of four different FML plates was equipped with a disposable cure sensor at one of their edges. Besides the long cables and the autoclave environment, the continuous measurement of the temperature and resistance in all sensors was quite smooth and accurate while the ORS system provided successfully the evolution of the T_g in all 4 sensor locations.

In conclusion the use of the Synthesites intelligent process monitoring system can provide a reliable means to achieve online T_g estimation during the FML manufacturing in an autoclave with a potential to decrease the curing time by 50% with respect to the recommended cure cycle.

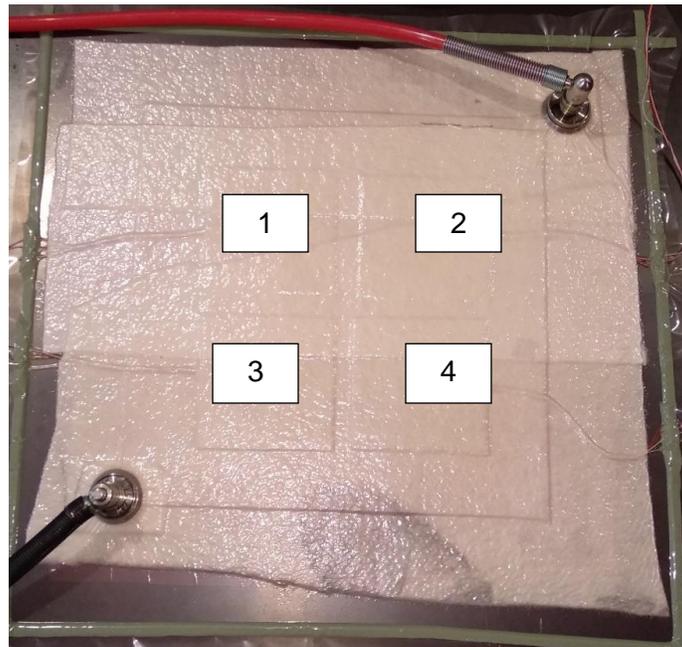


Figure 1. Numbering of the four different sandwich panels with one disposable sensor at each panel placed at different through-thickness location that were manufactured.

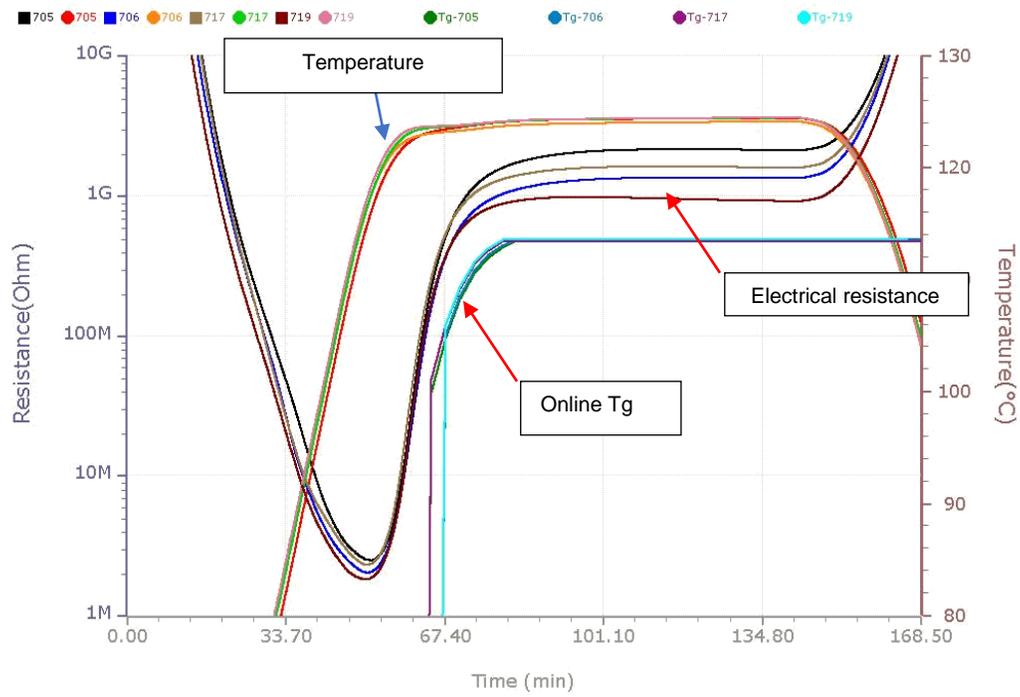


Figure 2. Evolution of curing (Resistance and temperature measurements of the four cure sensors and the estimation of Tg for these sensors as provided online during the process by the ORS system).