Etude des phénomènes de consolidation inter-pli de stratifiés PEKK/fibres de carbone en conditions de basse pression

Study of the interlaminar consolidation phenomena of carbon/PEKK laminates manufactured by out-of-autoclave process

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Thermoplastic matrix composites exhibit a lot of advantages over their thermoset counterparts such a high impact resistance and short process cycle time. Recently new high performance thermoplastic composites such as carbon/PEKK or carbon/PPS are attracting great attention from the aeronautic industry as cost effective alternatives to conventional carbon/PEEK composites. Nevertheless autoclave manufacturing which is often used to achieve high process temperature and pressure leads to the increase of manufacturing cost. One way to reduce manufacturing cost would be to develop out-of-autoclave processes where relatively low consolidation pressure is adopted. However the influence of low pressure manufacturing on the consolidation process of thermoplastic materials is not totally understood. [1]–[3]
We focus on low pressure consolidation of two types of unidirectional carbon/PEKK (Poly-Ether-Ketone-Ketone) laminates and in particular on the interlaminar consolidation phenomena.

At first an in-situ monitoring system of the laminates manufacturing has been developed which allows to follow the temperature gradient along the laminate's thickness and the variation of the thickness during the consolidation cycle. (Fig.1)

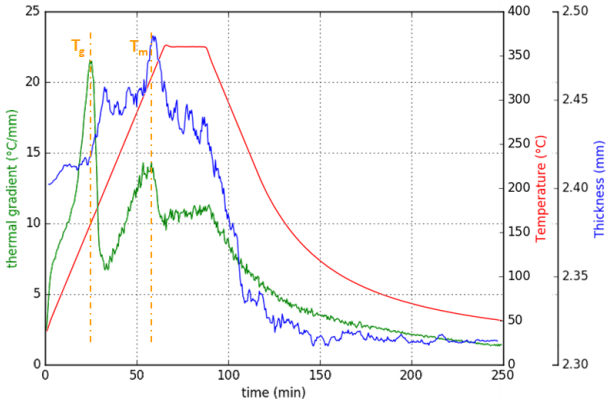

Fig. 1. Evolution of the temperature gradient, the bottom temperature and the laminate's thickness during consolidation cycle

By this monitoring system, two major consolidation phenomena can be identified: the one at the Tg and the other at the Tm. These phenomena are interpreted by peaks in the evolution of the thermal gradient. At the Tg the molecules chains in amorphous zones of the matrix take part in the creation of an intimate contact between the layers

Secondly we present the modelling of the major interlaminar consolidation phenomena. This part will especially focus on the thermal event at the Tg and on the flow of the fibers/resin mixture at the Tm. The first phenomenon corresponds to an evolution of thermal contact resistance at the interlayer. The FE modelling of this phenomenon takes into account the material parameters as surface roughness and initial crystallinity degree.
The prediction of composites flow is still challenging [4] because the viscosity of composites depends on the length and orientation of fibers. This presentation proposes a modelling of the flow at the interlaminar interface about the flattening of the prepreg's asperities under low pressure condition.

Out-of-autoclave manufacturing is possible to produce in some conditions thermoplastic composites with very low porosities and high interlaminar consolidation. In fact two major phenomena allow a good interlaminar consolidation: intimate contact and material flow. The identification and the FE modelling of these two phenomena have been performed. These works could be used to identify the material and process parameters which enable an optimal consolidation of thermoplastic laminates.

References

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