Capacity Area A3 Topic 1.2 Deliverable 3

Report on industrial demonstration of hybrid yarn consolidation

Laboratory of Composite Materials and Adaptive Structures, ETH Zurich, P. Ermanni

The direct stamp forming of hybrid bicomponent fibers into fully consolidated laminates has been demonstrated under industrial conditions in the lab:

Stamp forming of thermoplastic composites provides a fast and energy-efficient method for part production. The material is heated outside a press while the preceding part is formed and cooled inside the press, allowing the mold to be kept at constant temperature. This process currently relies on the use of pre-consolidated preforms, the preparation of which is slow and energy-intensive compared to stamp forming itself. Hybrid fibers, which individually combine each reinforcing filament with a precise amount of thermoplastic polymer matrix, provide an alternative solution. Preforms made from such fibers remain flexible at ambient conditions and can be stamp formed without pre-consolidation. This study investigates the consolidation behavior of unidirectional arrangements made from e-glass monofilaments clad in polycarbonate sheaths (69 vol.% glass). It assesses the influence of pre-heating temperature, press temperature, and holding time inside the press on the resulting laminates' void content. Samples were prepared using the previously proposed method of kiss-roll solution coating in-line with glass melt spinning as a fast and continuous fabrication process. The results prove that preforms made from hybrid fibers can be directly stamp formed while achieving void contents below 0.4 vol.% with dwell times inside the press as low as 5 s for 1 mm thick laminates.

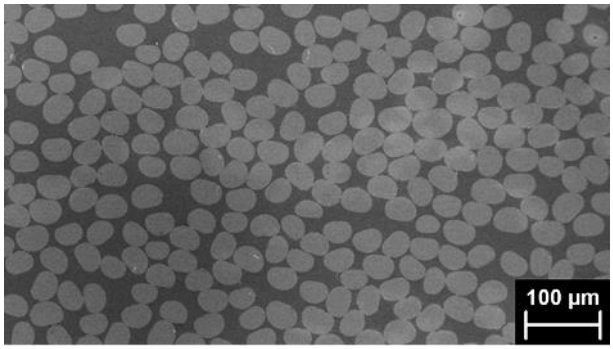

Fig. 1: Representative cross-sectional micrograph of a laminate stamp formed from e-glass/polycarbonate bicomponent fibers.

This work has been reported on in the doctoral thesis of Christoph Schneeberger, entitled "Hybrid Bicomponent Fibers for Thermoplastic Composites – Towards New Intermediate Materials for High Volume Manufacturing using Stamp Forming", Diss. ETH No. 26785.

The results of the empirical stamp forming study as outline above will also be presented at the Sampe Europe Conference 20 in Amsterdam on September 30 2020. The contribution entitled "Direct stamp forming of flexible hybrid fiber preforms for thermoplastic composites" is authored by Christoph Schneeberger, Nicole Aegerter, Sara Birk, Shelly Arreguin, Joanna C.H. Wong, and Paolo Ermanni.

https://www.sampe-europe.org/conferences/se-conference-20-amsterdam