Effect of processing parameters on quality of thermoplastic overmoulded composites

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Traditional manufacturing processes for pre-consolidated continuous fibre thermoplastic laminates (organosheets) offer excellent mechanical properties but are limited by geometrical design. The integration of an injection moulding stage to an organosheet thermoforming operation allows for the manufacture of combined short and continuous fibre reinforced composites that benefit from high intrinsic mechanical properties, geometric complexity and low production cycle times. It is demonstrated, through mechanical testing and microscopy of overmoulded CF-PPS ribbed plates, that the magnitude of the process-induced features and bond quality is influenced by the processing parameters.

Component Design and Manufacture

- An ARBURG 270C ALLROUNDER injection moulding machine was modified to overmould 33% short-carbon fibre PPS ribs onto a 5HS woven organosheet (Fig. 1.)
- Processing parameters varied during the manufacturing cycle (Fig. 2): organosheet pre-heating temperature (T), clamp force (F) and holding pressure profile (P).

Quality Assessment Methodology

- Process-induced features (yarn deformation, void content, fibre orientation and matrix displacement) quantified using optical microscopy.
- Mechanical performance (bonding force) evaluated via quasi-static rib pull-off tests at 2 mm/min.
- Custom steel fixture designed for testing, thus preventing organosheet bending and ensuring isolation of the overmoulded interface (Fig. 3.)

Results

- Higher holding pressure profiles can reduce the yarn deformation by up to 50% (Fig. 4.)
- Raising the pre-heating temperature from 350 °C to 370 °C results in a 27% increase in rib pull-off force, indicating stronger bonding.
- Interface failure pattern is influenced by the level of yarn deformation.

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