

Optical fibre sensor for monitoring flow and resin curing in composites manufacturing

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ABSTRACT

Process monitoring in composites manufacturing consists of the monitoring of (a) flow especially in filling type of processing techniques such as RTM and resin infusion and (b) resin curing. A major advantage of employing optical fibre sensors for the above purposes is that they can be used as local sensors at any mid-position across the thickness of the fibre preform or at the surface. An intensity-based optical fibre sensor was developed and tested in this study. The sensor length comprised the fibre core, initially surrounded by air or vacuum and subsequently covered by the infiltrating resin which cured as a function of time. The refractive index of the fibre core was higher than that of the surrounding medium in the time period of useful measurements.

The optical fibre flow sensor was tested in resin infusion under flexible tool (RIFT) in three configurations: the flow sensor length was placed (a) perpendicular to the flow direction at the top outer layer of the fibre preform, (b) perpendicular to the flow direction between fibre fabrics in the preform and (c) parallel to the flow direction. Cases (a) and (b) resulted in step changes in the measured light power output whereas case (c) resulted in a continual reduction of the measured light power output which was correlated to the sensor length covered by the epoxy resin yielding an analogue flow-sensor.

The optical fibre sensor was also tested in an epoxy resin system curing at room temperature with a gel time of approximately 500 min. A continual reduction of the measured light power output was obtained during the curing of the resin which was correlated to the corresponding viscosity change measured in an RDA II Rheometrics system, yielding the gel time of the epoxy resin and data about the reaction kinetics.