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Capillary effects in composite materials processing by Liquid Composite Moulding

During composite processing by Liquid Composite Molding (LCM), a fluid precursor of the matrix phase (an uncured thermoset resin, a thermoplastic polymer or a pre-polymer) is made to infiltrate the open pore space within a reinforcement preform. Understanding the flow kinetics governing the part production cycle time, and the final part quality in terms of void content and reinforcement homogeneity has been a main area of research over the past 20 years, enabling these processes to reach many industrial applications, in particular for medium volume applications. As most reinforcements are based on textile fabrics, the pore size distribution in the textile tend to show a binary profile, with small intra-tow spaces and larger inter-tow areas; the inner geometry of the textile fabric is thus a crucial parameter, that will influence not only the overall flow kinetics, through its permeability tensor, but also the flow front morphology, driven by the interplay between capillary and hydrodynamic effects. This last point is of course also highly related to the matrix material properties, i.e. surface tension and viscosity, and the textile surface properties The presentation will review through several recent examples of research in our laboratory, on the processing of thermoplastic and thermoset matrix composites by Liquid Composite Modling, the effect of capillary effects on the flow front kinetics and saturation, and the resulting guidelines for an optimised composite quality.