On-line mixing high speed RTM process simulation for Automotive mass production of carbon fiber reinforced structural components

Short cycle time Resin Transfer Molding (RTM) applications appear to be of great interest for the mass production of automotive or aeronautical lightweight structural parts. However these applications require high quality and low cycle times which can only be achieve thanks to fine understanding and control of the process. Therefore, research work has been launched to determine and quantify the micro and meso-scale mechanisms influencing resin flow and polymerization during the reactive RTM process with on-line mixing.

In a previous study, a dual-scale simulation tool has been developed to help determining the optimum injection parameters of the process. This tool allows tracking finely the repartition of the resin and the evolution of its properties during reactive injections with on-line mixing. Tows and channels of the fibrous material are considered separately to deal with the consequences of the dual-scale morphology of the continuous fiber textiles. The simulation tool reproduces the unsaturated area at the flow front, generated by the tow/channel difference of permeability. Resin "storage" in the tows after saturation is also taken into account as it may significantly affect the repartition and evolution of the temperature, degree of cure and viscosity in the part during reactive injections. The aim of the current study is, thanks to experiments, to understand and quantify the "storage" evolution in the tows to adjust and validate the numerical tool.

The presented study is based on four experimental repeats conducted on three different types of textiles: a unidirectional Non Crimp Fabric (NCF), a triaxial NCF and a satin weave. Model fluids, dyes and image analysis, are used to study quantitatively, the resin flow in the saturated area of the samples. Also textiles characteristics affecting the resin "storage" evolution in the tows are analyzed. Finally, fully coupled on-line mixing reactive injections are conducted to validate the numerical model.

Keywords—**Experimental, On-line mixing high speed RTM process, Dual-scale flow.**