

DOTTORATO DI RICERCA IN TECHNOLOGY, INNOVATION AND MANAGEMENT (DTIM)



PHD PROFILE, II YEAR STUDENTS, A.A. 2018/2019

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- Title of the research: Monitoring and Embedded Control of Liquid Composite Molding Processes
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OUTLINE OF THE RESEARCH

The wide use of composite materials (CM) in several sectors, namely aeronautic, automotive, health, sport, encourages scientist to investigate about these materials and their processability. Specific needs, related to the application of the final CM products, require peculiar deepening in each manufacturing technology. The techniques to manufacture CM are classified in two groups: in Autoclave Curing (AC) and Out of Autoclave curing (OoA) processes. Due to the high economic and environmental impact of AC manufacturing, researchers investigate alternative processes. One of the most consistent alternative is represented by the processes which belong to Liquid Composite Molding (LCM) class. They are based, in concept, on the filling of dry fibrous preform by resin driven by gradient of pressure. Due to this reason, LCM processes are performed in sailed molds. Nowadays, most of these processes are manually managed. Regarding this aspect, the challenge is to bring the process into the framework of the digital factory (Industry 4.0). The main objective of the research is to realize a monitoring and active control system of the LCM process. Through the acquisition of several variables, such as temperature and electrical impedance, and the action on thermal power and flow rate, it is possible to manage the process. A microwave system preheats the resin in a Vacuum Assisted Resin Transfer Molding (VARTM) line. Microwave power profile is preset in such a way to decrease viscosity, avoiding premature polymerization. The current literature already provides several works about numerical simulations, experimental activities or their combination in order to analyze, reproduce or optimize the characteristic phenomena occurring in these process. Nevertheless, there is still room for further deepening regarding the development of monitoring and active control systems.

This work is based on a strongly interdisciplinary approach, due to the necessity of the Design of Experiments (DoE) to plan laboratory tests, the numerical simulation, the study of flows in porous media, the artificial intelligence systems for the management of the process.