

Microwaves heating in composites laminates processing: advanced simulation based on the PGD in-plane-out-of-plane-decomposition

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ABSTRACT

Composites parts tend to represent an increasing volume of production in transport industry due to their combination of high mechanical properties and low mass. Although one aspect is still a disadvantage, this concerns their long cycle time.

Conventional processing methods for producing polymer composite parts usually involve the application of heat to the material by convection heating of the tool and composite. Conversely to these traditional heating methods that depend on surface heat transfer, microwave (MW) technology relies on volumetric heating which enables better process temperature control and less overall energy use, this can result in shorter processing cycles. These virtues of the MW technology have attracted interest in developing the method and adopting it for the production of composite materials. The main drawback of this technology today is that the complex physics involved in the conversion of electromagnetic energy to thermal energy (heating) is not entirely understood and controlled.

The principal objective of this work is to model the interactions of the MW field with the composite material (resin matrix, carbon fibers), at micro and meso scales. These models will simulate the way in which electromagnetic energy is converted to thermal energy within the material volume and the various interfaces. They will also describe how the local heat transfer mechanisms contribute to the overall heat transfer towards the produced part. The main challenge concerns the high-resolution description of the electromagnetic and thermal fields in a composite laminate, that involve plies whose characteristic in-plane dimension is of order of magnitude higher than the ones related to the thickness (typical aspect ratios are of tens of thousands).