Graphene nanoplatelets/epoxy nanocomposites as conductive adhesives for out-of-autoclave in-situ CFRPs repair

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Due to their good physical and chemical properties, such as high strength, low thermal expansion and chemical inertness, epoxy resins are widely used in the automotive, aerospace and construction sectors. However, the fact that these thermosets are not electrically or thermally conductive is limiting enormously their applications. With the aim of overcoming these important drawbacks and expanding the range of applications where epoxy-based materials can make an impact, micro- and nano- fillers with high electrical and thermal conductivities can be incorporated into it to fabricate epoxy nanocomposites with the electrical and thermal properties required for a particular application. Furthermore, the addition of carbon nanomaterials (*e.g.* graphene) into an epoxy matrix above the percolation threshold has recently been probed to provide these nanocomposites with outstanding electrothermal performances [1]. Indeed, the electrically conductive networks of nanoparticles formed in the polymer matrix shows the ability to act as integrated nanostructured heaters effectively transforming an electric current into heat through a simple Joule heating effect. This electrothermal property of conductive epoxy nanocomposite systems emerges as highly attractive for the development of a novel thermoset curing method trough resistive heating. This holds an enormous potential as an out-of-autoclave curing method that can replace the conventional oven curing one, opening the door to novel applications in the aerospace industry.

This work studies the potential of electrically conductive graphene nanoplatelets (GNPs)/epoxy composites for the development of an effective thermoset curing method through resistive heating. The structure of both oven cured and electrically cured GNPs/epoxy composites was evaluated and related to their electrical and mechanical properties. Results from DSC revealed that the electrically cured samples showed a complete curing degree, comparable to that found for the samples cured using the conventional oven. In addition, it was found that an alignment of the flakes was promoted in the direction of the applied current for the electrically cured samples, which was not found for the oven cured ones, and had a strong impact on the properties of the composite. How this anisotropy can be controlled and how it affects the composite electrical and mechanical properties and their electrothermal performance was studied. Going one step further, the potential of using this GNPs based resistive curing method for applications such as resistive reparation of CFs/epoxy components is also being investigated.

[1] T. Xia *et al.* Composites Science and Technology 164 (2018) 304-312.