GNPs/epoxy nanocomposites as conductive adhesives for Out-of-Autoclave in-situ Carbon Fibres Reinforced Polymers repair

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Carbon fibre reinforced polymers (CFRPs) have been widely used in the aerospace and automotive industries over the last decades due to their light weight and high tensile strength [1]. However, there are important issues associated with replacing or recycling damaged CFRPs. Indeed, the methods most commonly used to dispose waste CFRPs, i.e., landfill and incineration, involve high cost and energy consumption [2]. In addition, even though some efforts are currently being made on developing chemical and thermal methods for recycling them, they are quite aggressive and very often lead to irreparable damage to the carbon fibres [2]. Hence, strategies to efficiently repair damaged CFRPs at a low cost are in great demand [3]. Epoxy adhesives have been used for joining composite components because uncured epoxy wets well the adherend surface, promoting a strong interface and hence ensuring a good mechanical performance after curing [4]. Recently, researchers are adding micro/nano fillers into the adhesive epoxy matrix to improve the mechanical performance of the bonded joints [5]. However, the curing of these epoxy adhesives is normally performed in an autoclave, which use is labour-intensive and involve both high energy consumption and high cost. Thus, there is a desire to develop out-of-autoclave (OoA) strategies to repair CFRPs. Herein, we report the use of GNPs/thermoset nanocomposite mixtures as conductive adhesives for an in-situ out-of-autoclave (OoA) repair of CFRPs through Joule heat curing of the electrically conductive network of GNPs flakes embedded in the epoxy matrix. Due to the relevance of the bondline thickness for the targeted application, the electrical and Joule heating properties of the graphene/epoxy nanocomposite systems both as bulk and films were investigated as model systems and related to their microstructure. Establishing the structure/property relationship of the model systems allowed most promising GNPs loadings to be taken forward as conductive adhesives for in-situ OoA CFRPs repair. The influence of the adhesive's GNPs loading on the heating rate and distribution of the Joule heat generated during the repair process was investigated to optimize the process. The mechanical properties of the CFRPs repaired by Joule heat were compared with those found for the CFRPs repaired in an oven. The failure mechanism of the joints was also studied to gain insight on new directions to improve this OoA repair method.

References

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