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NANOREINFORCED MATRICES FOR CARBON FIBER MULTISCALE REINFORCED COMPOSITES

Abstract

The use of continuous carbon fiber reinforced composites is widely extended in the aerospacial field, due mainly to their extraordinary good specific properties, which makes them very useful in an industry in which a kilogram sent to the space has an average cost of 40000 $.

These materials have an anisotropic mechanical behaviour, as the direction in which the fibers are orientated has a big influence on the final properties. Consequently, the employment of this kind of materials are highly dependant on design tools that have allowed to taylor structural pieces for each aerospace project.

As the properties measured on fiber direction are very high, improvements in continous fiber composites are focused on the development of some functional properties, such as electrical or thermal conductivity, and mechanical properties when measured in the transverse direction to the carbon fibers disposition plane. These improvements are related to modifications of the matrices used in the composites manufacturing, but keeping a low density material.

The addition of nanoreinforcements to the polymer matrices tries to add new functionalities to the polymers used as matrices, keeping their mechanical behaviour or even improving some aspects as toughness of fragile matrices such as epoxi ones. Electrical and thermal conductivity can be improved by the addition of very low concentrations of nanoreinforcements with high aspect ratios such as carbon nanofibers and nanotubes. The nanometer scale allows the electrical conductivity without the need of contact among the particles due to the tunnel effect that can take place at this scale.

Manufacturing of nanoreinforced matrices is currently being studied in multiple researching works, mainly due to difficulties when dispersing the nanoreinforcement. Nanoparticles tend to keep entangled in agglomerates due to the high specific surface available that makes these aggregates very stable. Also this property causes big increases in the viscosity of the polymer, which

Nanoreinforced epoxy matrices have been used to impregnate carbon fiber fabrics in order to get multiscale reinforced composites by vacuum infusion technique (VARIM), that could be used in aerospace applications due to their good specific mechanical properties and low thermal expansion coefficient. Dispersion of the nanoreinforcement and of the impregnation stage have been studied in order to evaluate the limitations of these matrices due to their high viscosity and the possible filtration of the nanoreinforcements that could lead to an heterogeneous presence of them in the final composite. Also mechanical and dynamomechanical properties were evaluated.