ISGC 2022

N°782 / OC
TOPIC(s) : Polymers or composites

Innovative process for uncured carbon fibers prepreg recycling and functionalization with magnetic nanoparticles using supercritical fluid chemistry

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PURPOSE OF THE ABSTRACT

An innovative and sustainable process, using supercritical fluid (SCF) chemistry, was used to recycle uncured prepregs and functionalize the recovered carbon fibers with Fe3O4 magnetic nanoparticles (MNP). For the first time, supercritical CO2 extraction was used for extract partially some components of prepreg's formulation, followed by a functionalization step. This allows to produce new types of secondary raw material useful for composite applications (TP or TS). Complementary, initial 'cradle-to-gate' Life Cycle Assessment reveals that recovery of post-industrial composite waste through supercritical CO2 consists of a promising and environmental-attractive recycling route, avoiding the hazard emissions when virgin carbon fibers are produced and showing cost-efficiency and lower energy-consumption benefits. The functionalization with MNP allows the fibers to be heated by induction, for easy end-of-life reclamation of CF and recycling [1]. Using SCF and hydrothermal conditions for recycling and functionalization is a way to use less solvents [2] and allow to get ready-to-use fibres.

IMA/M21E (UD) from Hexcel uncured prepreg, available in large quantity in aeronautic industry was chosen as model. After cutting prepreg at desired length to fit in the future applications, a supercritical CO2 extraction is performed under 40°C and 29 MPa in a semi-continuous reactor for ten hours to: (i) remove partially some components of the uncured prepreg matrix and stop the polymerization (Figure 1 - step 1), (ii) remove the tacky behaviour of prepreg, often a limiting factor for their reuse. Then, the recycled carbon fibers (rCF), still embedded inside the remaining organic matrix, are brought into contact with reactants into the reactor for the functionalization step (Figure 1 - step 2). Two possibilities were studied: (i) the synthesis of MNP coated with PAA in hydrothermal conditions, and (ii) the deposition of already synthetized MNP coated with oleic-acid, assisted by supercritical CO2-acetone. These allow to produce ready-to-use materials with homogeneous depositions of MNP at the surface of rCF, giving them a strong magnetic behaviour, and no damage on the fibers.

Some examples of way to use these new materials, ie rCF with and without functionalization will be presented for composite applications.

Acknowledgement: This work is funded by the European Union's Horizon 2020 research and innovation programs entitled: 'Recycling and Repurposing of Plastic Waste for Advanced 3D Printing Applications' (Repair3D) under GA No. 814588.

FIGURES

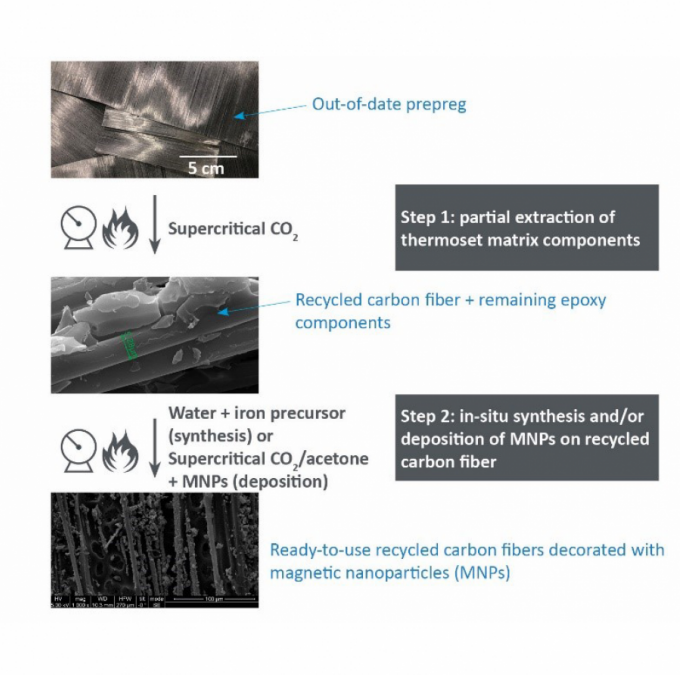

FIGURE 1

Figure 1

Diagram flow explaining the innovative process for uncured prepreg recycling using supercritical fluid chemistry

FIGURE 2

KEYWORDS

supercritical fluid chemistry | composite recycling | nanoparticles functionalization

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