Supercritical Emulsion Extraction to produce polymeric microcapsules for self-health monitoring applications

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Aerospace and automotive structural components undergo a progressive corrosion over time caused by a wide variety of environmental and operational load factors. The employment of capsule-based strategies containing a chromophore capable of monitoring structural integrity and revealing a damage may be the right approach. In this study, an efficient and green process was used to produce microcapsules acting as a health-monitoring visual element. The aim was to disperse the produced capsules in a designed protective coating with the intrinsic capability to highlight cracks suffered during the operating conditions. Supercritical Emulsions Extraction (SEE-C) technology was used to encapsulate a health-monitoring mixture based on DiGlycidyl Ether of Bisphenol A (DGEBA), dyed with Solvent Red 242, in polymethylmethacrylate polymer (PMMA).Process operating parameters were optimized to produce spherical and separated microcapsules. Different emulsion formulations were tested varying polymer concentration in the external oil phase and dyed DGEBA amount in the internal oil phase. Effect of the dye concentration on the process efficiency was also investigated. A comparison between SEE-C and Solvent Evaporation (SE) was also carried out in term of mean size diameter (MSD), encapsulation efficiency (EE) and time stability (TS) of the produced microcapsules. Best results were obtained using supercritical technology: spherical microcapsules with unwrinkled and smooth surface with higher EE were obtained using SEE-C. SEE-C capsules preserve their stability for the entire time frame analyzed of a month.
Impact tests were carried out on strips of Carbon Fiber Reinforced Composites (CFRCs) coated with a green aqueous paint, in which the SEE-C capsules were previously dispersed. The protective coating was very sensitive in showing stress areas: characterization analyses showed dye leaking associated with capsule breaking in the stressed areas, even using low impact energies.

Graphical abstract