Use of supercritical CO_2 for the preparation of polymer/carbon nanotubes foams that are effective protective materials against electromagnetic pollution

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The very fast development of gigahertz electronic systems and telecommunications is responsible for the steadily increasing electromagnetic pollution, which justifies a very active quest for effective electromagnetic interference (EMI) shielding materials. A large range of applications is concerned from commercial and scientific electronic instruments to antenna systems and military electronic devices. Polymers filled with carbon fillers (e.g., carbon black, carbon fibers and carbon nanotubes) have been extensively investigated for EMI shielding purposes because of unique combination of electrical conductivity and polymer flexibility. The use of carbon nanotubes (CNTs) offers substantial advantages over conventional carbon fillers because they can simultaneously enhance the electrical conductivity and reinforce the mechanical performances of the filled polymers. Moreover, the nanotubes can percolate at very low contents (<5 wt.%) as result of their high aspect ratio.
However, a major drawback of the nanocomposites that contain carbon nanotubes is a high propensity to reflect the electromagnetic radiations rather than to absorb them. Indeed, the reflection of the signals results from the difference of permittivity at the interface of the material, thus between the air and the nanocomposite. The introduction of air into the nanocomposite by the formation of an open-cell foam will be favorable to decrease this difference and thus, to increase the absorbing capacity of the material. For that purpose, $scCO_2$ has been used to foam carbon nanotubes nanocomposites based on different polar polymer matrices. The effect of filling content, pressure and temperature on the main properties of the foam (density, pore size…) has been widely studied which allowed us to isolate several materials with high shielding efficiencies combined with a low reflectivity in a broad frequency range (1-40 GHz).

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