Foaming in $CO_{2\ sc}$ medium as an efficient way to produce Electromagnetic Interference Shielding Materials

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Introduction. The sharp increase in electromagnetic pollution due to the fast development of gigahertz electronic systems and telecommunications justifies a very active quest for effective electromagnetic interference (EMI) shielding materials. Most of the time, metallic boxes are used as shielding materials, acting as EMI reflectors and not as absorbers[1]. As an alternative, polymers filled with carbon fillers[2] (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 (CNT) offers substantial advantages over conventional carbon fillers because they can simultaneously enhance the electrical conductivity and reinforce the mechanical performances of the filled polymers.[3] A major drawback of CNT/polymer nanocomposites[4] is a high propensity to reflect EM radiations instead of absorbing. For the particular case of electronic device protection, the emitted wave does not cross the composite material, but EMI prevails in the inner volume as a result of multiple reflections from the walls, that may alter proper operation of the device.[5]

For an EMI shielding material to absorb electromagnetic radiations, its dielectric constant must be as close to that of air as possible.[5] A straightforward approach to this highly desirable situation relies to foaming of CNT containing polymers. The relative volume of air in an open-cell foam is high, and therefore favorable for the matching of the wave impedances of the expanded material and the ambient atmosphere.

Results and Discussion. This communication reports on the preparation of novel nanocomposites foams that are efficient broadband microwave absorbers.[7] Multi-walled carbon nanotubes (MWNT) are first successfully dispersed into polymer matrix by melt-blending as confirmed by TEM microscopy and rheology. Then foaming of these nanocomposites[8] occurs under supercritical CO_2 conditions by a two-step process.[9] This physical foaming constitutes a green alternative to classical foaming agents.[10] Well-defined microcellular foams[11] were obtained with cell size around 10-50 µm and cellular density around 10^8 cells per cm^3, the morphology of the foam was determined by SEM microscopy. The impact of several criteria on the morphology of the foam will be discussed. The EMI shielding efficiency of these materials are then evaluated and compared to the non-foamed nanocomposites. Finally, we will discuss about the design of the foam that is essential to optimize the performances of the EMI absorber.

Conclusions. New nanocomposite materials with high electromagnetic wave absorption effectiveness have been successfully prepared with the use of supercritical CO_2 as the foaming agent. It was found that adding voids into the nanocomposite improved substantially the wave absorptive capacity, thus reducing greatly the signal reflection. The resulting material is also much lighter and more flexible than metallic counterparts currently used, making them very attractive from an industrial point of view.

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