High porosity graphene/CNT hybrid scaffold with excellent electromagnetic interference shielding

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Microwave absorbing and shielding materials are having an ever increasing interest because of the increasing environmental pollution from electromagnetic radiation due to the fast development in communication technology [1]. Absorber materials are designed to attenuate and absorb electromagnetic energy and converting it into heat. Metals are the most common materials for EMI shielding. They function mainly by reflection due to the free electrons in them. Metal sheets are heavy and bulky, so it´s necessary to look lighter materials with high absorption capacity. Graphene sheets and carbon nanotubes (CNTs) are reported as the high-performance absorbing materials with respect to their much better intrinsic properties compared with traditional absorbing materials [2]. If CNTs (1D) and graphene (2D) can be merged, novel 3D sp^2-hybridized carbon structures could be obtained. The electronic, mechanical and surface properties of these hybrid systems would be significantly different. When an electromagnetic wave propagating through a free space with impedance of Z_0, happens upon a dielectric material boundary of impedance Z_M, a partial reflection occurs. The reflection coefficient at the interface can be expressed as: $R= (Z_M-Z_0)/(Z_M+Z_0)$. The reflection coefficient falls to zero when $Z_M=Z_0$. Whereby, for the design of an absorber is necessary that their surface impedance is as close as possible to the incident wave impedance Z_0. For this purpose, porous materials are a good alternative.

The microscopic organization of the nanocomposites to obtain better macroscopic properties could a synergistic effect between the intrinsic properties of nanoparticles and properties provide a microscopic organization of them. Self-assembly and reduction of graphene oxide (GO) into interconnected graphene networks are achieved by heat treating aqueous GO suspensions for a certain amount of time inside containers (Teflon-lined autoclave) [3]. To these GO dispersions are added an amount of oxidized CNT, monoliths obtained after the hydrothermal process are formed by both compounds. GO provides good mechanical properties while CNT enhance electrical properties of the monolith. Monoliths obtained in the process of hydrothermal synthesis have microporous morphology. For hierarchical pore morphology is used a modified hydrothermal method reported by Li et al. [4] recently. This method involves preparing stable aqueous emulsion of graphene oxide (GO) containing hexane droplets. This is

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[5] This work was supported by grants Nanomod (MAT2010-17091) from the Spanish Ministerio de Ciencia e Innovación.

possible due to GO amphiphilicity, which can act as emulsion stabilizer. For this reason, during hydrothermal process, GO sheets were reduced and assembled around hexane droplets to form a 3D network.

In this work it has achieved a porosity control of the GO/CNT hybrid scaffolds. We have prepared (Figure 1) scaffolds varying the GO/CNT concentration. An exhaustive characterization of CNT and GO before and after of HT was carried out. SEM images show than morphology consists of microporosity due to HT and macroporosity (≥200 µm) due to hexane droplets (Figure 2). Conductivity results show values since 8 until 60 S/m. These results agree with the electromagnetic characterization: Absorbed power (about 80%) was higher than the reflection power (about 20%). Furthermore, the higher the concentration of CNT, the bigger the reflection and the less absorption. Electromagnetic shielding over 20 dB were obtained only with thickness of 9 mm.

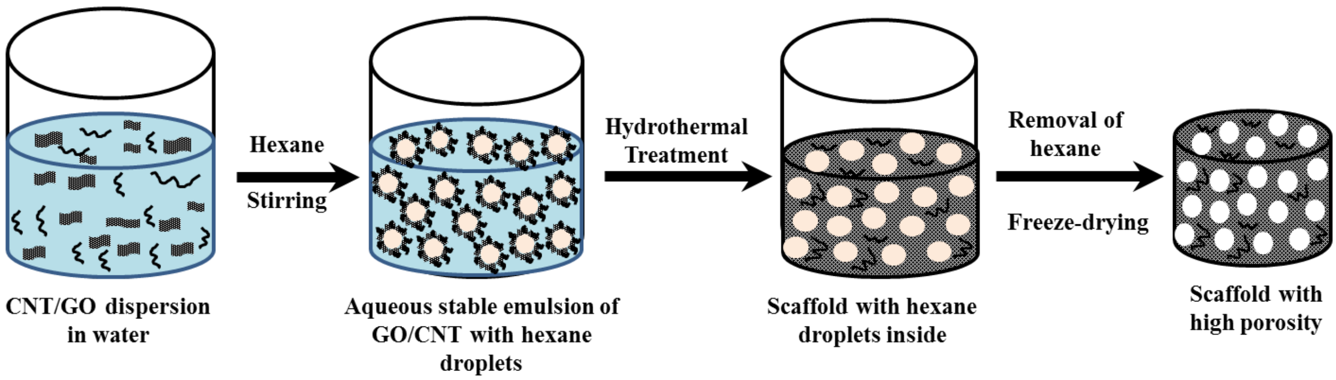

Fig. 1- Schematic illustration of the synthetic process of GO/CNT hybrid scaffold with high porosity

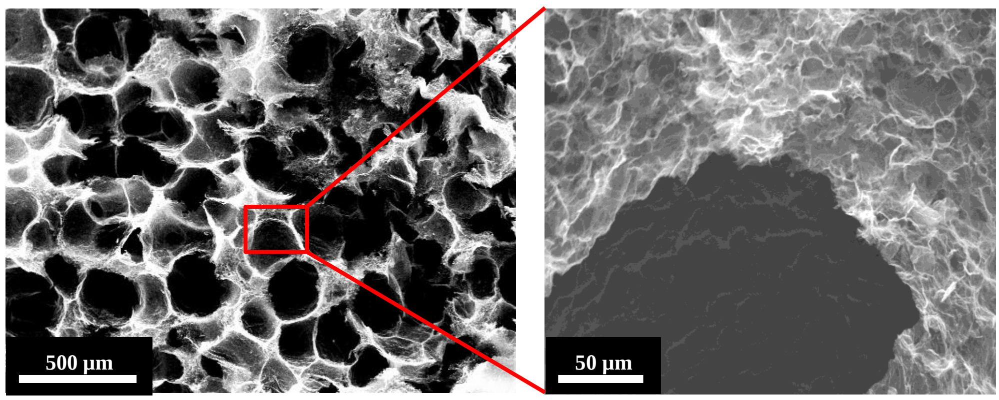

Fig.2- SEM images of GO/CNT hybrid scaffold