Engineering nanodiamond-PANI nanocomposites: structural features and mutual arrangements

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Innovative composites formed by detonation nanodiamond (DND) inserted in Polyaniline (PANI) matrices have been prepared and investigated. PANI is one of the moSt interesting conducting polymers, with striking electronic and optical properties, widely used as matrix for the preparation of nanocomposites. However the use of detonation nanodiamond as gueSt component of PANI-based nanocomposites was never been proposed up to now. As a general rule, the fillers are viewed as agents able to modify some functional properties of the matrix, and a variety of nanocomposites based on DND are presently designed and manufactured for a variety of applications. In such a context, this research was aimed at the investigation of the mutual lay-out of DND and conducting polymers, and of the architectures obtained by coupling them. Several preliminary and stimulating results were obtained from deep investigations carried out by using FE-SEM, TEM, TED, XRD and micro-Raman. FirSt of all, it has been evidenced that the DND dispersions did not modify substantially the structural features of the polymer. Nevertheless, the arrangement of the polymer segments and the spatial distribution of DND appear to be reciprocally influenced. These effects seem to be correlated to the increase of the thermal stability and reduction of the T-induced decomposition of the PANI backbone, as detected by TGA and DGT measurements. From the structural point of view, the moSt intriguing result has been the discover that the DND crystallites embedded in the PANI matrix show an unexpected preferential self-orientation probably driven by the tendency of PANI chains to a self-organization in elongated architectures. For embedded DND crystallites a slight modification of interplanar distances has been also detected

From the functional point of view an important consequence of the DND insertion is the speed-up of the polymerization process, demonstrating a high catalytic activity on the chemical oxidative polymerization of the momomer. Electrochemical tests also indicate that DND/PANI materials act as efficient catalytic mediator for some processes of electron transfer.

Overall these DND-PANI materials are not only promising for challenging technological applications but also important for the controlled growth of polymeric units, for the fabrication of nanoarchitectures and for understanding the mechanisms of crystallites alignment/orientation triggered by foreign structures.