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Extended Abstract

Materials Chemistry 2019: Innovative chemistry and nanotechnology-based surface engineering of hydrophobic tungsten disulfide (WS2) Inorganic Nanotubes (WS2-INTs) - novel nanoscale functional Bio-Active Inorganic “NanofillersR- Jean-Paul (Moshe) Lellouche- Bar-Ilan University, Institute of Nanotechnology & Advanced Materials - BINA, Israel

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Abstract

Tungsten disulfide nanotubes (INTs-WS2) are extremely hydrophobic and chemically inert inorganic nanomaterials. This feature quite strongly limits their usefulness in numerous mechanical hardness and tribology-relating research developments and subsequent industrial/bio-active end-applications. Thus, the covalent versatile linkage of any kind of functional organic and/or biology-relating species remains a quite critical developmental step towards highly innovative high-performance nanomaterials and multiphase composites in the field of essential interfacial versatile chemistries. In such a highly challenging methodology/ functionalization issue context concerning these chemically inert hydrophobic nanomaterials, an innovative method of surface functionalization (versatile polycarboxylation ??? polyCOOH shell formation) of multi-walled inorganic nanotubes (INTs-WS2) and fullerene-like (IFs-WS2) nanoparticles has been successfully developed. This covalent functionalization method makes use of highly electrophilic and reactive imminium salts (Vilsmeier-Haack (VH) complexes-reactions) in order to enable the introduction of a chemically versatile polyacidic (polyCOOH) shell onto the surface of VH-treated inorganic nanomaterials. Moreover, a significant statistical Design Of Experiments (DoE) method has been also involved for global optimization of this multi-parametric polyCOOH shell generation.

This novel INTs-nanotube sidewall polyCOOH functionalization enabled innovative-targeted interfacial chemistries. Indeed, it enabled the effective nanofabrication of a wide range of covalent WS2-INTs surface modifications (polyNH2, polyOH, polySH) via (i) polyCOOH chemical activation (EDC, CDI) and (ii) 2nd step covalent nucleophilic substitutions by short -aminated bifunctional ligands H2N-linker-X (X outer surface functionality). Moreover, an additional innovative surface engineering methodology for same multi-walled inorganic nanotubes (INTs-WS2) has been also discovered via use of small 5.5-6.0 nm-sized lanthanide action/complex-doped magnetic maghemite nanoparticles towards corresponding magnetically responsive inorganic nanotubes for photo-thermal therapy (PTT) anti-cancer bioactivity. Resulting fully characterized functional INTs-WS2 (f-INTs-WS2) have a quite wide potential for use as novel functional nanoscale fillers toward new mechanically strengthened and/or conductive composite polymeric matrices (case of hybrid polythiophenedecorated f-INTs-WS2 nanocomposites, Figure 1). Corresponding novel functional nanomaterials/nanoscale fillers have been also shown to be PTT bioactive and non-toxic in preliminary toxicity studies, which opens a wide R&D route/progress for relating end-user applications (cellular toxic CNTs nanofillers replacement for example).

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