World Academy of Science, Engineering and Technology
International Journal of
Vol:8, No:, 2014

A Bottom-Up Approach for the Synthesis of Highly Ordered Fullerene-Intercalated Graphene Hybrids

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Abstract : Much of the research effort on graphene focuses on its use as building block for the development of new hybrid nanostructures with well-defined dimensions and behavior suitable for applications among else in gas storage, heterogeneous catalysis, gas/liquid separations, nanosensing and biology. Towards this aim, here we describe a new bottom-up approach, which combines the self-assembly with the Langmuir Schaefer technique, for the production of fullerene-intercalated graphene hybrid materials. This new method uses graphene nanosheets as a template for the grafting of various fullerene C60 molecules (pure C60, bromo-fullerenes, C60Br24, and fullerols, C60(OH)24) in a bi-dimensional array, and allows for perfect layer-b--layer growth with control at the molecular level. Our film preparation approach involves a bottom-up layer-by-layer process that includes the formation of a hybrid organo-graphene Langmuir film hosting fullerene molecules within its interlayer spacing. A dilute water solution of chemically oxidized graphene (GO) was used as subphase on the Langmuir-Blodgett deposition system while an appropriate amino surfactant (that binds covalently with the GO) was applied for the formation of hybridized organo-GO. After the horizontal lift of a hydrophobic substrate, a surface modification of the GO platelets was performed by bringing the surface of the transferred Langmuir film in contact with a second amino surfactant solution (capable to interact strongly with the fullerene derivatives). In the final step, the hybrid organo-graphene film was lowered in the solution of the appropriate fullerene derivative. Multilayer films were constructed by repeating this procedure. Hybrid fullerene-based thin films deposited on various hydrophobic substrates were characterized by X-ray diffraction (XRD) and X-ray reflectivity (XRR), FTIR, and Raman spectroscopies, Atomic Force Microscopy, and optical measurements. Acknowledgments. This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF)-Research Funding Program: THALES. Investing in knowledge society through the European Social Fund (no. 377285).

Keywords : hybrids, graphene oxide, fullerenes, langmuir-blodgett, intercalated structures