Novel Synthesis Method for Three-Dimensional sp-2 Carbon Structure for Nuclear Waste Management

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Carbon Nanotubes (CNTs) have been found to have unprecedentedly high thermal and electrical conductive properties, as well as high sorption potential, in initial research studies of the material. The nuclear industry has been exploring CNTs for use is nuclear waste management in the form of functionalized Multi-Walled CNTs (MWCNTs), which are CNTs doped with other chemical compounds to specifically target radionuclides for separation from the mixture of many radionuclides. Current methods of creating three-dimensional carbon structures have been limited to CNTs that are vertically or radially aligned and only one or two layers of graphene thick resulting in a fragile structure that is often very costly to create. Other forms of these structures are also synthesized by randomly arranged carbon nanostructures with no repeatable or homogeneous pattern. The development of these three-dimensional carbon structures with significant structural strength and durability, with still significantly high electrical and thermal conductivities, is a primary goal for many research agendas focused on material waste. This study focuses on a new form of graphene-only, three-dimensional structure fabrication methods using a nanoscale laser lithography system. The three-dimensional structure initially made of a multi-element photoresist goes through a pyrolization process to burn off all non-carbon species. Through nickel chemical vapor deposition (Ni-CVD), the crystal structures of many carbon allotropes are realigned to solely match the sp-2 crystal structure during a second pyrolization process, ensuring a purely graphene three-dimensional structure. A novel synthesis method for constructing a purely graphene, multilayered nanostructure is explored in this study under controlled nanotechnology laboratory environments.