Controlled Porosity in Carbon Nanotube Assemblies via Latex Crystal Templating

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Colloidal crystals - three-dimensionally ordered close-packed arrays of spherical colloids have found applications in many areas, for example assembling photonic materials, optical coatings, lithographic etching masks and sensors. Self-assembled colloidal crystals are also ideal scaffolds for templating periodic, nanostructured materials. The general concept for such templating techniques involves self-assembly of colloidal crystals by sedimentation, spin-coating, vertical deposition, etc. with interstitial spaces filled with other materials, such as conductive nanofiller. The template can be subsequently removed and an inverse replica of the template's microstructures left behind We show a novel template route for the production of macroporous composites with void structures. For this objective, colloidal crystals composed of polystyrene spheres are used as the template material that acts as a scaffold for amine-functionalized MWNTs carbon nanotubes (NH_2-MWNT) cross-linked chemically with a glutaraldehyde (GA) solution. GA provides an intermolecular cross-link that acts as an "anchoring" unit and enables the formation of a 3D nanotube network. The polymer matrix is later removed in order to produce a macroporous carbon nanotube sheet. These templates can be ordered over centimetre length scales and the thickness and porosity can be tailored in manufacturing. We also show that the sheet resistance of a NH_2-MWNT sheet is moderately high compared to the ordinary MWNT buckypaper. It can potentially find applications where control of the pore size is critical.