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Functionalization of Single-Wall Carbon Nanotubes for Their Use in Biological Applications

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Single-wall carbon nanotubes (SWCNTs) are a promising material for future biological applications such as imaging, targeted drug delivery, biosensors, and nanomechanical systems. SWCNTs can be solubilized in water through surface functionalization, a priority for their use in biology. By studying the surface chemistry of SWCNTs, various functionalization methods can be utilized to exploit the useful surface properties of the nanotubes, without perturbing their electronic structure. This study probes the use of functional groups or biological molecules such as phospholipids to noncovalently functionalize SWCNTs, maintaining useful optical and physical properties. Phospholipids are conjugated to polyethylene glycol (PEG) or DNA and anchored onto the sidewalls of SWCNTs by hydrophobic surface interactions. Copper-free click chemistry is used as a means to cross-link a phospholipid to DNA. In this approach, a phospholipid containing dibenzycyclooctyne (DBCO) is reacted with azide-functionalized DNA, linking the two biomolecules by a triazole moiety. Biofunctional materials such as DNA or proteins can be attached to the functionalized nanotubes and used for biological applications. Functionalization is characterized by optical methods and atomic force microscopy (AFM). By functionalizing SWCNTs with groups that are biocompatible, they show greater promise in future biological applications.

Graduate research advisor Jing Pan writes, "Research on carbon nanotube functionalization provides avenues for manipulating these strongly hydrophobic nanomaterials so that they can be made useful for numerous applications. By making carbon nanotubes soluble in water, their great electronic surface properties can be exploited and used in biology and medicine."

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