Peptides as Selective Agents for Carbon Nanotube Dispersion

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Single-walled carbon nanotubes (SWNT) are unique for the following reasons – they are made up of one element (carbon), every atom is on the surface, and their electronic properties are controlled solely by their diameter and chirality. Typical synthesis processes such as laser ablation or CO disproportionation produce ropes of SWNT comprised of both metallic and semi-conducting tubes. The separation of individual tubes for the synthesis of electronic devices is a major challenge. We have discovered specific peptides with selective affinity for carbon nanotubes via phage display. Consensus binding sequences show a motif rich in Histidine and Tryptophane amino acids. Analysis of the hydrophobicity of the peptide chains suggests that they act as symmetric detergents, with a hydrophobic region in the middle and hydrophilic regions at the ends. Binding specificity has been confirmed by demonstrating direct attachment of nanotubes to phage and free peptides immobilized on microspheres. The importance of the specific motif is shown by point mutation experiments that result in large changes in binding strength. A statistical mechanical treatment of peptide conformations shows a folding pattern in the binding sequence consistent with the geometry and structure of carbon nanotubes. Our findings open the possibility that short peptides with specific binding for different types of nanotubes can be found.