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Optical modulation of single walled carbon nanotubes

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Recent advances in the spectroscopy of single walled carbon nanotubes have significantly enhanced our ability to understand and control their surface chemistry, both covalently and non-covalently. Our work has focused on modulating the optical properties of semiconducting single walled carbon nanotubes as near infrared photoluminescent sensors for chemical analysis. Molecular detection using near-infrared light between 0.9 and 1.3 eV has important biomedical applications because of greater tissue penetration and reduced auto-fluorescent background in thick tissue or whole-blood media. In one system, the transition of DNA secondary structure modulates the dielectric environment of the single-walled carbon nanotube (SWNT) around which it is adsorbed. The SWNT band-gap fluorescence undergoes a red shift when an encapsulating 30-nucleotide oligomer is exposed to counter ions that screen the charged backbone. We demonstrate the detection of the mercuric ions in whole blood, tissue, and from within living mammalian cells using this technology. Similar results are obtained for DNA hybridization and the detection of single nucleotide polymorphism. We also report the synthesis and successful testing of near-infrared β-D-glucose sensors2 that utilize a different mechanism: a photoluminescence modulation via charge transfer. The results demonstrate new opportunities for nanoparticle optical sensors that operate in strongly absorbing media of relevance to medicine or biology.