Nanoscale Science and Devices: Applications in Biology

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The advent of techniques and devices exploiting nanoscale phenomena promises to bring about a revolution in biological sciences. Coupling biomolecules with nanostructures leads to novel scaffolding techniques for developing novel nanosensors and devices. For example, free energy variation due to biomolecular interactions can be detected with high precision using mechanical devices for biosensing applications such as characterization of single nucleotide polymorphisms. We have demonstrated the discrimination of DNA mismatches using an elegantly simple microcantilever-based optical deflection assay, without the need for external labeling. The advantage of this mechanical detection includes discrimination of mismatched DNA as well as determination of the amount of hybridized and physisorbed DNA molecules. This technique is readily adaptable to a high-throughput array format, and provides a distinct signal for easy interpretation of oligonucleotide hybridization. The second part of the talk will focus on quantum phenomena, nanoparticles, quantum-confined atoms, and directed assembly of nanoparticles using engineered DNA. Quantum confined atoms are impurity atoms trapped within semiconductor crystals that are about 2-3 nm in size. Sensors and devices based on the effect of quantum confinement in modifying the overlap between host and dopant electronic states, whereby the properties of the confined atoms are retained and protected, while its interaction with the host is significantly enhanced, will be discussed.

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