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Nanoparticle quantum nanosensors: Prospect of detection of single biological molecules using quantum coherence

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Conventional plasmonic sensors are based on intrinsic resonances of metallic nanoparticles (localized surface plasmons). In many quantum dot sensors variations of energy transfer from one type of quantum dots to another type or to metallic nanoparticles are used for detection of biological molecules. In this report we propose ultra-sensitive sensors based on fundamentally different concepts and principles. In these sensors the rules of quantum mechanics are used to detect biomolecules. These quantum nanosensors are based on hybrid systems consisting of metallic nanoparticles and quantum dots. Interaction of these systems with a laser field generates quantum coherence, allowing us to convert minuscule changes in the environment into dramatic optical events detectable by conventional and simple electronic and optical means. These sensors are not based on excitons or plasmons as in conventional sensors, rather they are founded on the way environment influences dynamics of coherent exciton-plasmon coupling and the intrinsic resonances (plasmonic meta-resonances) of the hybrid quantum dot-metallic nanoparticle systems. We will show how such sensors can offer ultrahigh sensitivity with very wide dynamic range for detection of single biological molecules and variations of the level of biological and chemical substances in the environment.

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