Biofunctionalized Fluorescent Nanoparticle Probes

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Research in fluorescent nanoparticle probes is driven by the need for bright chromophores for imaging and high throughput bioassays. We are developing a novel type of biofunctionalized fluorescent nanoparticle probe with higher brightness and unique optical properties for enhanced, ultrasensitive sensors. The fluorescent nanoparticles are based on a class of polymers known as pi-conjugated polymers, which are intrinsically fluorescent, semiconducting polymers. We have developed methods for fabricating conjugated polymer nanoparticles ranging in size from 3 nm (the size of a single polymer molecule) to 50 nm in diameter. Our results indicate that this novel class of fluorescent nanoparticle has unparalleled fluorescence brightness, many times larger than that of other fluorescent nanoparticles such as CdSe quantum dots.

A key goal of this research is the further development nanoparticle-based fluorescent tags for a number of demanding applications such as DNA detection, flow cytometry, fluorescence microscopy, biomedical imaging, and single molecule tracking. A multifaceted research strategy is employed, including nanoparticle synthesis, encapsulation, bioconjugation, nanoparticle characterization using fluorescence spectroscopy, and advanced imaging and spectroscopy experiments. A distinguishing feature of this research program is the opportunity for students to gain familiarity with advanced methods such as atomic force microscopy (AFM) and picosecond time-resolved fluorescence spectroscopy for measuring the morphology and optical properties of individual nanoparticles and bioconjugated sensors. Interested students can also be involved in the development and application of novel scanning probe microscopy and spectroscopy techniques such as *in vivo* single biomolecule tracking and single molecule spectroscopy. Additional applications such as nanoparticle-based oxygen sensors, nanoparticle-based agents for phtodynamic therapy, and photoswitching nanoparticles are also currently under investigation.

An important aspect of this research is that a diverse range of techniques will be employed. Undergraduate students will be able to quickly gain proficiency in nanoparticle synthesis and in using standard optical methods such as UV-VIS and fluorescence spectroscopy and move on to more advanced techniques of scanning probe microscopy and spectroscopy. The research involves a number of small, modular projects that can each be accomplished in a few weeks.