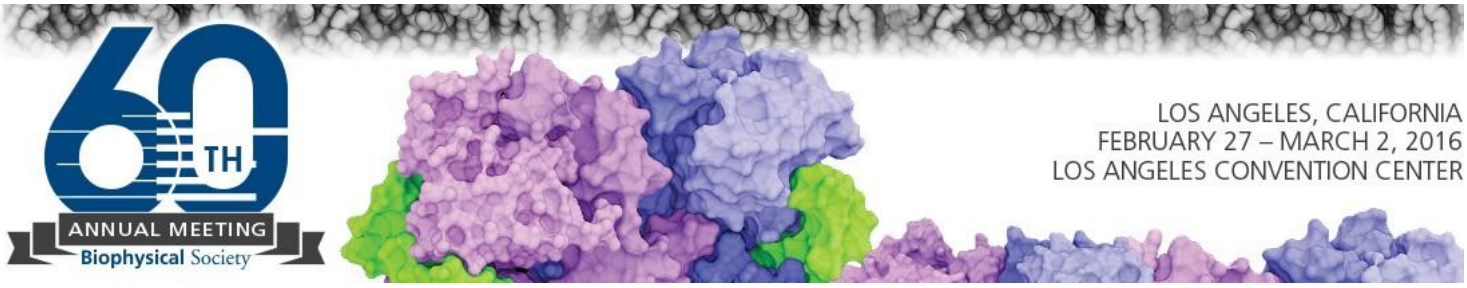

Control/Tracking Number: 16-A-304-BPS

OPTICAL DETECTION OF BIOLOGICAL ACTIVITY, ONE MOLECULE AT A TIME

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Abstract:

Molecular recognition is central to the design of therapeutics, chemical catalysis and sensor platforms, with the most common mechanisms involving biological structures such as protein antibodies. However, identifying and isolating an antibody for a particular biological molecule is often costly and time-consuming, and their use is limited to physiological conditions in which protein antibodies remain stable. Furthermore, most metabolites lack molecular recognition elements. Therefore, the biggest limitation to metabolite detection has been the selective and sensitive detection of biomolecules that have no naturally-occurring molecular detection counterpart. Nanomaterials are of a similar size to the molecular entities that govern life within cells, and are therefore well-suited to studying life at the sub-cellular scale.This work reports the development of a synthesis platform for the design of synthetic sensors, based on the principle of polymer corona phases surrounding near-infrared optically active nanoparticles. The design of such sensors is based on the adsorptive properties of engineered heteropolymers to carbon nanotubes, which create a unique corona with molecular recognition properties for a target analyte. This phenomenon is shown to be generic, with new recognition complexes demonstrated for riboflavin, l-thyroxine, and estradiol, and confirmed with single-molecule imaging of the nanotube and the corona phase. The immediate utility of this platform was confirmed in its application to discover the first optical sensor for neurotransmitter dopamine, and was applied to monitor vitamin trafficking in living macrophage cells for over an hour. Furthermore, this platform has most recently been used in the scope of “plant nanobionics”: the detection of molecular pollutants inside living plants. The analyte library for these sensors could be amplified to identify synthetic sensors for a variety of different molecules for which there currently exists no detection method.

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