Photonic Crystal Nanocavities: A Label-free Method to Study Molecular Interactions

(21 July 2016)

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Fluorescence imaging provides a powerful approach to study fundamental life processes and has become an integral part of the toolbox for biologists. In order to study molecular interactions, single molecule imaging requires labeling the molecules with fluorescent reporters. The influence of these fluorescent labels to the molecular interactions has been unknown. In this talk, the speaker will present photonic crystal nanocavities as a new tool to study molecular interactions at the single molecule level. By coupling a single plasmonic nanoantenna with photonic crystal nanocavity non-resonantly, we can achieve both high quality factor and ultra-small mode volume, thus pushing the detection limit to the single molecule level while keeping the local heating effect at a negligible level. With this approach, the speaker and his group studied the interaction between single DNAs and proteins and measured their binding on and off rates. They further quantified how fluorescent labels (such as FITC and GFP) could change the on and off binding rates between DNAs and proteins. Photonic crystal nanocavity sensors also have various applications in diagnostics. The speaker will also present examples and discuss limitations of applying these photonic crystal nanocavities in detecting biomarkers in complex environment (e.g. serum). In summary, the nanocavity label-free approach, complementary to the fluorescent imaging methods, will broaden our understanding of basic life processes at molecular level and will provide new ways for drug discovery and disease diagnostics.