Tunable Integrated Plasmonic–Photonic Cavities for Label-free Optical Sensors

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Herein, we propose an integrated label-free detection platform comprising a plasmonic–photonic cavity that allows sensitive molecular detection via either surface-enhanced Raman scattering (SERS) or plasmon resonance energy transfer (PRET). A small droplet of metal ion solution spontaneously produces a photonic cavity on the surface of uncured polydimethylsiloxane (PDMS), and as PDMS is cured, the metal ions are reduced to form a plasmonic antennae array on the cavity surface. Unique spherical feature and the integrated metallic nanoparticles of the cavity provide excellent optical functions to focus the incident light in the cavity and to re-scatter the light absorbed by the nanoparticles. By using the cavity, we accomplish both 1000-fold sensitive detection and real-time monitoring of reactive oxygen species secreted by live cells via PRET. In addition, we achieve sensitive detection of trace amounts of toxic environmental molecules such as chloromethylisothiazolinone/ methylisothiazolone and bisphenol A, as well as several small biomolecules like glucose, adenine, and tryptophan, via SERS.