WELL-ORDERED PLASMONIC NANOSTRUCTURE FOR BIOSENSING

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An LSPR biosensor holds attractive advantages of low-cost, capacity of high integration, requirement of simple optical configuration, surpassing commercial mechanical, or propagating surface plasmon resonance (PSPR) biosensors for construction of miniaturized biomedical devices. Well-designed metal nanostructures with "hot-spots" (the region with intense electromagnetic field, mostly located at sharp nanotips, nanoedges, or nanoslits), possessing superior bulk refractometric and molecular detection sensitivity, are ideal candidates for LSPR biosensors. Therefore, sharp tips in nanostructures play an essential role in improving the performance of LSPR sensor.

Here, we present an overview of our recent work on using a well-ordered plasmonic nanopyramid array with sharp tips for highly-sensitive refractometric and surface enhanced Raman biosensing. Firstly, we introduce a well-ordered Al nanopyramid array (NPA), fabricated by a facile method of elastic soft lithography and subsequent metal deposition. This Al NPA with sharp tips possess high refractometric sensitivity of ~ 820.4 nm/RIU, which even exceeds that of metal nanobranches. Secondly, we characterize the strongly enhanced local electric field at the tip of nanopyramid in comparison to Al flat film (FF), by performing finite difference time domain (FDTD) simulations. Lastly, we apply this plasmonic nanostructure to real-time monitoring the proliferation of Hella cells. The peak positions of the measured transmission spectra is found linear to the culturing time. After 96 hours, the maximal peak shift is ~ 7.2 nm.

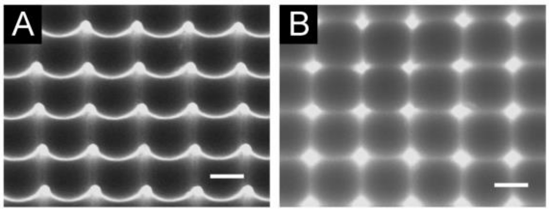

Fig. 1 Construction of Al nanopyramid array (NPA). (A) Side-view SEM images of Al NPA at 45°. (B) Top-view SEM images of Al NPA. The scale bars 1 μm.

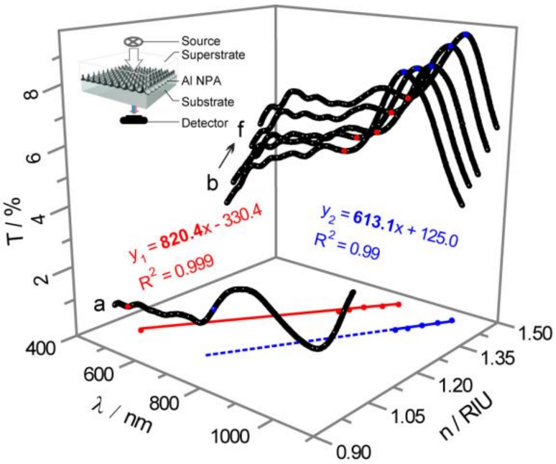

Fig. 2 Transmission spectra of Al NPA when the superstrate is air (curve a) and glycerol/water mixtures with different refractive indexes (curve b to f). The inset displays the detection configuration performed in transmission mode. And the relationships between the wavelength of two resonance peak (marked with red/blue points) and corresponding n is presented at XY plane. Error bars are two small to be seen. The results fit in linear lines with its slopes indicating the refractometric sensitivities.

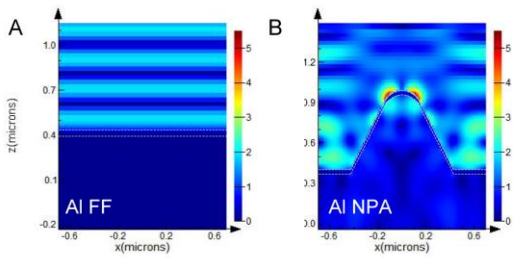

Fig. 3 FDTD simulations of electric field distribution for Au flat film (FF) and Au NPA with light at normal incidence. Strongly enhanced electric field was observed at the sharp tip.

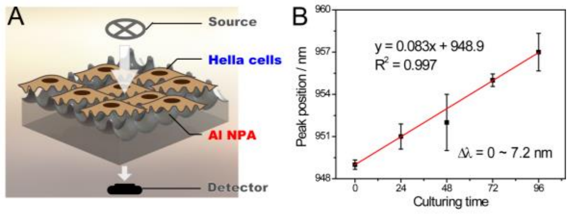

Fig. 4 (A) Schematic diagram illustrating the process of Al NPA monitoring for Hella cells' proliferation. (B) Relationship between LSPR signal (peak positions) and proliferation time. The maximal peak shift $\Delta\lambda_{max} \approx 7.2$ nm.

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