

Novel Plasmonic Interferometric Biosensor Arrays For High-Performance Label-Free Biomolecular Detection

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We investigate a class of plasmonic interferometric biosensors that consist of arrays of circular aperture-groove nanostructures patterned on a gold film for phase-sensitive biomolecular detection. These biosensors achieve superior performance within a microscale footprint by combining SPR interactions with sensitive interferometric techniques. The phase and amplitude of interfering surface plasmon polaritons (SPPs) in the proposed device can be effectively engineered by structural tuning, providing a flexible and efficient control over the plasmon line shape observed through SPP interference. Spectral fringes with high contrast, narrow linewidth, and large amplitude have been experimentally measured and permit sensitive detection of protein surface coverage as low as 0.4 pg/mm². This sensor resolution compares favorably with commercial prism-based surface plasmon resonance systems (0.1 pg/mm²), but is achieved here using a significantly simpler collinear transmission geometry, a miniaturized sensor footprint, and a low-cost compact spectrometer, showing great promise to develop fast, inexpensive, compact biomedical devices. Furthermore, we also demonstrate superior sensor performance using intensity interrogation method, which incorporates CCD imaging to upgrade our platform for high-throughput array sensing. A novel low-background interferometric sensing scheme yields a record high sensing figure of merit (FOM*) of 146 in the visible region, surpassing previous plasmonic biosensors and facilitating ultrasensitive high-throughput detection.