Controlling Nanoscale Geometries and Biomolecular Interactions on Gold coated nanopillar arrays for Highly enhanced Plasmonic Biosensing

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Introduction

Biosensors that can deliver highly sensitivity, quick response times, and are also economically viable are continually in demand due to emerging diagnostic needs targeting the detection of biomarkers at ultralow levels. Nanoplasmonic sensing especially based on Metal Enhanced Fluorescence (MEF) and Surface-enhanced Raman spectroscopy is a promising tool to deliver sensitivity in the picomolar to femtomolar concentration regime, within duration of few minutes. Amongst key challenges to the rational development and optimization of the plasmonic bioassays on chip include (a) difficulty to realize spatial resolutions down to few nanometers, over large areas, at low costs; (b) Large standard deviations in geometries and heterogeneity across the sample resulting in lower signal enhancements, and high signal intensity variations; (c) difficulty in precisely correlating nanoscale geometry with optical/spectroscopic properties, and with biomolecular response making it difficult to rationally design the metal nanorods (d) lack of independent means to optimize biomolecular interactions on the plasmonic sensor, and inability to determine actual surface concentrations that contribute to the plasmonic signal intensity. To this end, the presented work demonstrates gold nanopillar arrays with separations controlled down to sub-10nm regime, derived out of self-assembly of block copolymer colloids, investigation of Geometry. Biomolecular response MEF/SERS signal intensity correlations. The approach would help rational design and optimization of high performing plasmonic bioassays.

A. Engineered Nanoscale Geometry

Amphiphilic DI-block copolymer Self-assembly from solution Reverse micelles Periodic template RIE Etching Gold coated Nanopillar Arrays

B. Biomolecular Interactions

Optimization of Biotin & surface interaction to have maximum S.avidin & Biotin interaction

C. Spectroscopic Response

Plasmonic based Biosensing Biomolecular Interaction

References

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Conclusions

The self assembly based nanofabrication approach presented here provides promising means to tailor the metal array geometries down to molecular resolutions. The investigation of the biomolecular response independent of the SERS signals allowed three advantages: (a) Optimization of the bio-assay independent of the plasmonic sensing, (b) An alternative means to report the actual surface concentrations that contributes to the SERS signals (c) To unambiguously attribute the cause of issues in the plasmonic assay to either optical processing, the geometries, or the bioassays. Thus obtained correlations of geometry ◀ biomolecular response and geometry ◀ optical response opens doors to rational design of plasmonic arrays towards fast, reliable and quantitative detection of biomolecules.

References