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Simulation and Fabrication of Plasmonic Lens for Bacteria Detection

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Abstract : Plasmonics has been regarded one of the most powerful bio-sensing modalities to evaluate bio-molecular interactions in real-time. However, most of the plasmonic sensing methods are based on labeling metallic nanoparticles, e.g. gold or silver, as optical modulation markers, which are non-recyclable and expensive. This plasmonic modulation can be usually achieved through various nano structures, e.g., nano-hole arrays. Among those structures, plasmonic lens has been regarded as a unique plasmonic structure due to its light focusing characteristics. In this study, we introduce a custom designed plasmonic lens array for bio-sensing, which was simulated by finite-difference-time-domain (FDTD) approach and fabricated by top-down approach. In our work, we performed the FDTD simulations of various plasmonic lens designs for bacteria sensor, i.e., Samonella and Hominis. We optimized the design parameters, i.e., radius, shape, and material, of the plasmonic lens. The simulation results showed the change in the peak intensity value with the introduction of each bacteria and antigen i.e., peak intensity 1.8711 a.u. with the introduction of antibody layer of thickness of 15nm. For Salmonella, the peak intensity changed from 1.8711 a.u. to 2.3654 a.u. and for Hominis, the peak intensity changed from 1.8711 a.u. to 3.2355 a.u. This significant shift in the intensity due to the interaction between bacteria and antigen showed a promising sensing capability of the plasmonic lens. With the batch processing and bulk production of this nano scale design, the cost of biological sensing can be significantly reduced, holding great promise in the fields of clinical diagnostics and bio-defense.

Keywords : plasmonic lens, FDTD, fabrication, bacteria sensor, salmonella, hominis
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