Nanotransfer Printing of plasmonic nanostructures on convex lens for highly sensitive image-based biosensing

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Plasmonic biosensors have been attracted growing attentions in recent years because of their unique properties of high sensitivity, label-free operation, and suitable for high-throughput real-time detection. In the past decade, studies have focused on the plasmonic biosensor and achieved ultra-high sensitivity up to 1×10^3, and high figure of merit up over 800.[1-2] However, real-life applications of plasmonic biosensors are still scare. Because the performance of plasmonic biosensors strongly depends on the geometric properties of the nanostructure, the fabrication methods of plasmonic biosensors often involves time-consuming, sophisticated vacuum-based processes, e.g., e-beam lithography, and evaporation of materials. Moreover, the evaluation of biomolecules using plasmonic biosensors is usually based on costly and complicated spectroscopic techniques, which also hinder their applications. Therefore, development of plasmonic biosensors with low fabrication cost and fast, accurate, and user-friendly non-spectroscopic evaluation methods is of importance.

In this research, we proposed a facile, use-friendly and cost-effective image-based plasmonic biosensor to detect the concentration of various biomolecule, such as IgG, by using a plasmonic microchip on a lens patterned with a diffractive convex grating. Gold nanograting and nanodisk array are nanotransferred onto the bottom surface (spherical surface) and top surface (flat surface) of a convex lens, respectively. The convex grating works as a simplified offner spectrometer: broadband light first through the biomolecule-attached gold nanodisk, then diffracted by the convex grating. The first-order diffractive pattern is then recorded by a monochrome camera. The recorded diffraction pattern is related to the surrounding medium of the gold nanodisk, thus could be utilized for sensing the environmental changes induced by the attached biomolecules. The schematic process flow is illustrated in **Figure 1**. Firstly, a layer of imprint resist is spin-coated on a cleaned conductive indium tin oxide (ITO) glass substrate and nanoimprinted with nanopatterns. Then, gold is electrodeposited on ITO through the exposed grooves in the mask using a home-built electrodeposition system. Next, the sample is gently immersed in acetone to remove the imprint resist. Afterwards, a layer of poly (vinyl alcohol) (PVA) is spin-coated on the sample, and peeled-off manually with gold nanostructures embedded as the intermediate transferring film. The PVA film is then attached to the target substrate and heated above the glass transition temperature of PVA (120 °C) to further enhance the adhesion. Finally, after immersing in water for 30 min to dissolve PVA, the gold nanodisk array is transferred and firmly attached to the substrate. **Figure 2** shows the working scheme of the biosensor. The lens-based biosensor is assembled with a microchannel, and illuminated with a broadband light shoots down on the lens. The diffractive patterns are recorded by a monochrome camera. Then, the refractive index

changes in the microchannel chip could be obtained by tracking the recorded diffractive patterns.

1 Shen, Y., Zhou, J., Liu, T. et al. Nat Commun. **2013**, 4, 2381.

2 Cai, J., Zhang, C., Liang, C., Min, S., Cheng, X., Li, W.-D., Advanced Optical Materials, **2019**, 7, 1900516.

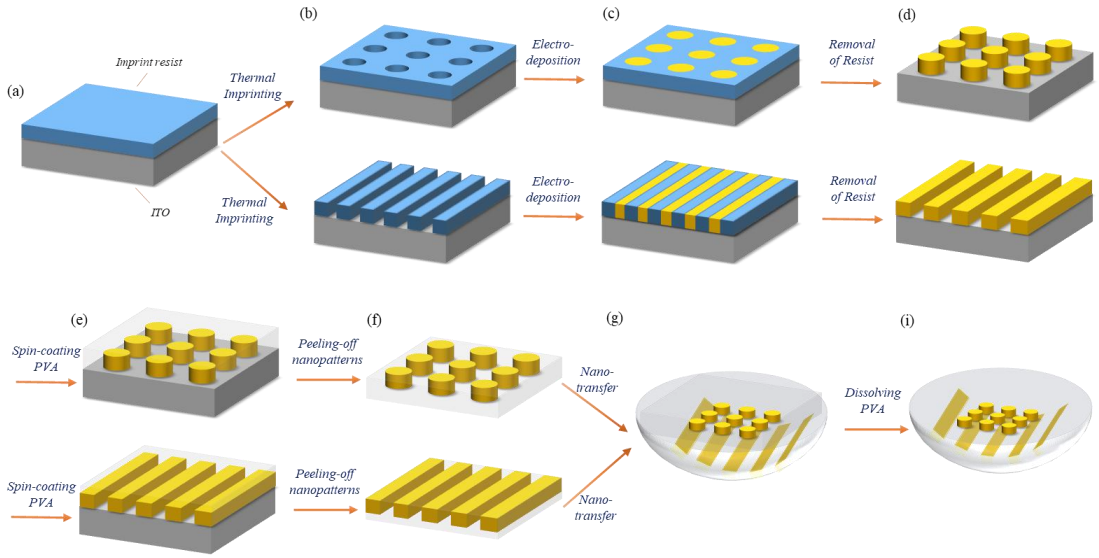

Figure 1. The schematic process flow of fabrication.

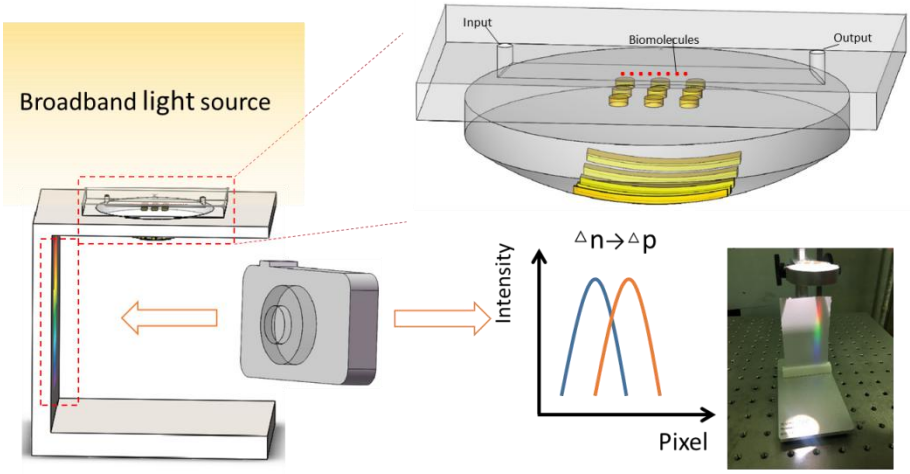

Figure 2. Working scheme of the biosensor.