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Pressure-free nanoimprinting for LSPR biosensor substrate fabrication and application as an immunoassay chip in human IgA detection

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[Background] Researches on exquisite nanoparticle or nanostructure for LSPR nanobiosensors have been conducted for over decades due to their superior immediacy in detection, versatility in target analyte, and high potential in sensitivity which make them ideal for POCT (Point-of-care testing) applications. A metallic nano-surface is conventionally fabricated using EBL; however, this limits the POCT suitability since aside from being high-cost, poor performance for large working area and unadaptable to flexible morphology design remain as challenges. Hence, in this work a novel nanoimprinting-based, tunable, easy to scale up and possible of mass-production at low-cost method will be demonstrated. This is considered as a game-changing method as it's capable of being performed at room-temperature and with no requirement of pressing force. Merits mentioned above fitly meet the needs of biosensor development for POCT application standards.

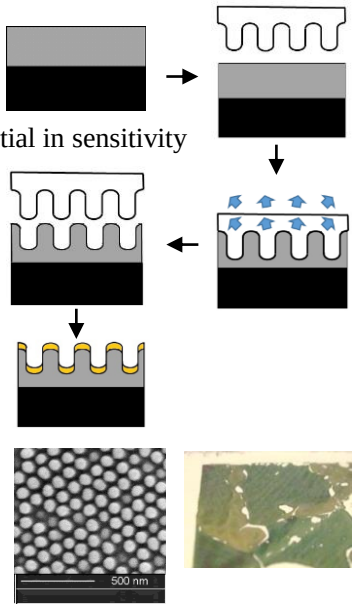

Fig1. Work flow of producing LSPR biosensor chip via pressure-free nanoimprinting lithography with PDMS film-mold and HSQ sol-gel resist (top); SEM image and photo of completed LSPR chip (Au=50nm) (bottom)

[Experiments] In our previous reports, procedure for porous master mold anodization to nano pillar structured COP secondary mold fabrication has been well articulated. Film-like thin PDMS mold was formed with a μ-patterned silicon wafer substrate and COP nano pillar structured mold utilizing a thermal nanoimprinting apparatus. Subsequently, the 170μm thin PDMS porous mold was spread onto spin coated liquid phase HSQ (Hydrogen Silsesquioxane) polymer sol-gel layer spontaneously. By curing at room temperature and for less than 40 minutes of time, nanopillar structure was transferred onto the cured polymer resist. Immunoassay experiments were performed onto this nanopillar structured surface after Au nano-layer sputtering (50nm)[Fig1].

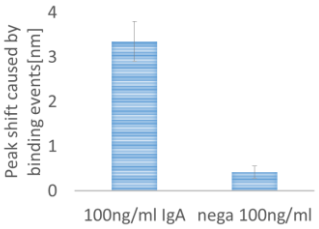

Fig2. IgA detection results

[Results and discussion] Absorbance peak caused by LSPR has been confirm at around 530nm wavelength for 50nm Au-sputtered chip. Immunoassay application was done by modifying the metallic surface with Anti-IgA molecule. From the negative control sample (CRP100ng/ml), the peak barely shifted after antigen delivery, while a positive specimen (100ng/ml IgA) triggered a remarkable absorbance shift due to specific antigen-antibody binding events [Fig2].

[Reference] Anal. Chem., 2012, 84 (13), 5494‑5500.