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Contact Transfer Printing Using Bi-layer Functionalized Nanobio Interface for Flexible Plasmonic Sensing

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In this paper, we present a fabrication method of functionalized gold nanostructures on flexible substrate that can be implemented for plasmonic sensing application. For biomolecular sensing, many researchers exploit unconventional lithography method like nanoimprint lithography (NIP), contact transfer lithography, soft lithography, colloidal transfer printing due to its usability and easy to functionalization. In particular, nanoimprint and contact transfer lithography need to have anti-adhesion layer for distinctive metallic properties on the flexible substrates. However, when metallic thin film was deposited on the anti-adhesion layer coated substrates, we discover much aggravation of the mold by repetitive use. Thus it would be impossible to get a high quality of metal nanostructure on the transferred substrate for developing flexible electronics based transfer printing. Here we demonstrate a method for nano-pillar mold and transfer the controllable nanoparticle array on the flexible substrates without an anti-adhesion layer. Also functionalization of gold was investigated by the different length of thiol applied for effectively localized surface plasmonic resonance sensing. First, a focused ion beam (FIB) and ICP-RIE are used to fabricate the nanoscale pillar array. Then gold metal layer is deposited onto the patterned nanostructure. The metallic 130 nm and 250 nm nanodisk pattern are transferred onto flexible polymer substrate by bi-layer functionalized contact imprinting which can be tunable surface energy interfaces. Different thiol reagents such as Thioglycolic acid (98%), 3-Mercaptopropionic acid (99%), 11-Mercaptoundecanoic acid (95%) and 16-Mercaptohexadecanoic acid (90%) are used. Overcoming the repeatedly usage of the anti-adhesion layer mold which has less uniformity and not washable interface, contact printing method using bi-layer gold array are not only expedient access to fabrication but also have distinctive properties including anti-adhesion layer free, functionalized bottom of the gold nano disk, repeatedly replicate the pattern on the flexible substrate. As a result we demonstrate the feasibility of flexible plasmonic sensing interface and anticipate that the method can be extended to variable application including the portable bio sensor via mass production of stable nanostructure array and other nanophotonic application.

Keywords: Anti-adhesion layer free, Contact printing, Flexible substrates, Bio-functionalization, Localized surface plasmon resonance (LSPR), Surface enhanced raman scattering (SERS), bio-molecular sensing

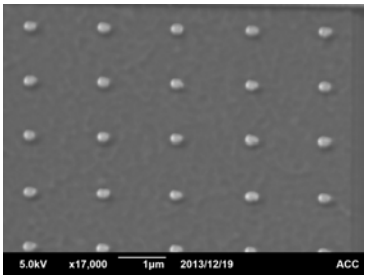

Fig. 1

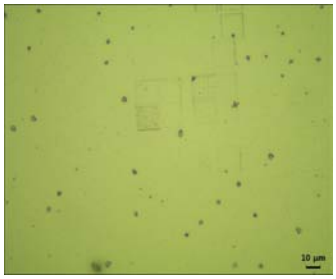

Fig. 2

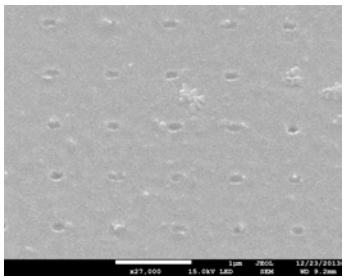

Fig. 3

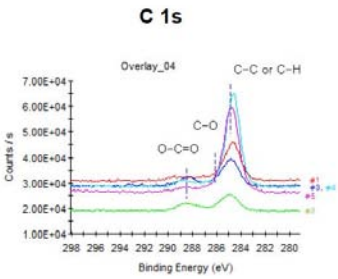

Fig. 4