Western Nanofabrication Facility

Western Science

High-Performance Nanohole Array Sensors Fabricated by Template

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Nanoplasmonics has been developing fast because of recent nanofabrication advancement. Traditional methods include focused ion beam (FIB) milling, electron beam lithography (EBL) and deep UV lithography. They are either time-consuming or require complex and expensive systems. Template approaches involving soft lithography, nanoimprint lithography and so on, can make nano-structures in a more efficient and cost-effective way due to the use of templates with relief patterns.

Solid objects of different size, shape and composition have been transferred to various substrates by controlling adhesion between different interfaces. Here we demonstrate a template transfer method for fabrication of nanohole array sensors using a high resolution template formed by EBL. The Si template of the nanohole array was patterned using EBL followed by deep ion etching. An e-beam lithography system (LEO 1530) was used to pattern square arrays of circular nanoholes with 200 nm diameter and 600 nm pitch on the PMMA resist spin-coated on a Si wafer. The features were then transferred to the Si substrate using a deep reactive ion etching machine (Alcatel 601E). After removing the PMMA mask in piranha solution, the template was thoroughly rinsed with ultrapure water and dried with N_2. A 100 nm thick Au film was then deposited onto it without adhesion layer. Au nanohole arrays formed on the top surface of the template were then transferred to PDMS (Sylgard 184, Dow Corning) substrates by means of conformal contact to and removal from the template.

A major merit is that the template can be repeatedly used many times, therefore reducing the cost and time consumption of nanofabrication. In addition, this process does not require any additional resist processing, etching, or liftoff. This advantage is of great benefit, especially in biological applications, compared to conventional nanofabrication techniques based on chemistry processing. Sensors fabricated by the template transfer approach are featured with high sensitivity 522 nm/RIU. Although our current work is focused on subwavelength holes in continuous Au films, the template transfer technique is equally applicable to fabrication of other nanoplasmonic architectures such as nanoparticles and nanorings.

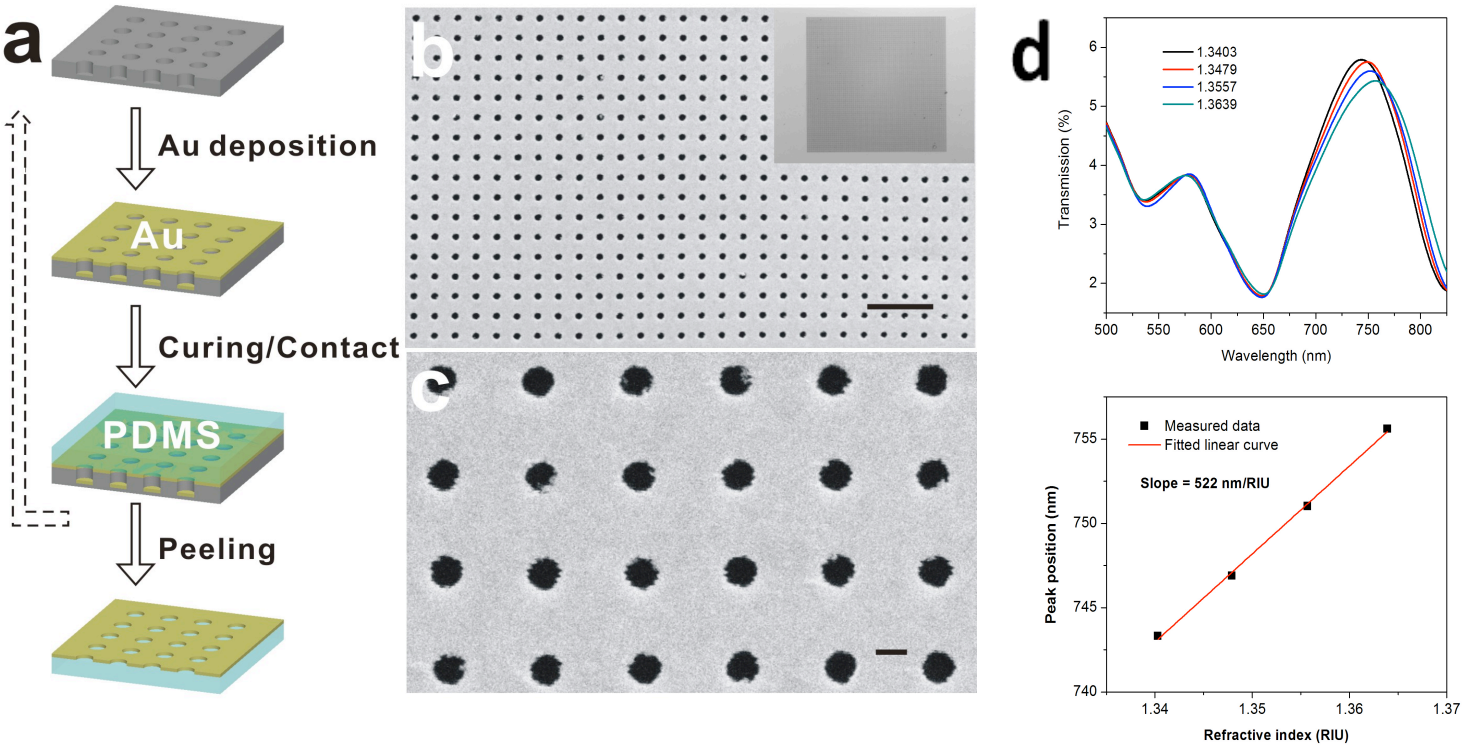

Figure (a) Schematic for transfer of Au nanohole arrays from the Si template to PDMS substrates. (b,c) SEM images of the nanohole array transferred to PDMS. Scale bars 2 micron and 200 nm, respectively. Optical image inset. (d) Transmission spectra and sensitivity of the fabricated nanohole array sensor.

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