Use of nanoimprint lithography to prepare metallic corrugated structure exhibiting ultrasensitive refractive index sensing

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A convenient, fast monitoring of environment provides people an in-situ perception of surrounding variations or dangers. In situ sensing system normally involves changes in optical or electronic signal. Via observing these signal changes, one can quickly recognize the variation of environment. To monitor environmental change, the most efficient method is to detect the refractive index of surrounding medium. Surface plasmon resonance (SPR) has been widely applied on refractometric sensing [1], and also has been widely utilized in label free biological and chemical sensing [2].

In this study, we prepare a metallic corrugated structure for application as ultrasensitive refractive index sensor. Relying on nanoimprint lithography, the fabrication of metallic corrugated structure was easily achieved (Figure 1). Applying different imprint pressures results in currogated structures with various curvature. The plasmonic characteristics of these metallic corrugated structures were fully discussed. The refractive index sensors based on the corrugated Au film exhibited an ultrahigh sensitivity closed to 800nm/RIU, which was comparable or even higher than other SPR–based sensors reported (Figure 2a). Due to the unique index-matching effect, refractometric sensing could be determined by the transmission intensity of Au/substrate SPR mode as shown in Figure 2b. Besides, the refractometric sensing based on the transmission intensity of Au/ substrate mode could be conveniently carried out without a spectrometer but only a light source and a photodetector. To demonstrate the potential of corrugated Au film on refractometric sensing, we used the corrugated Au film to determine unknown refractive indices of ethanol solutions of different concentrations. From comparison between the reference RI and the calculated one determined from resonance wavelength-shift and transmission intensity, we concluded that our chemical sensors had dual criterions for refractometric sensing and were highly sensitive and accurate. In the last, we have demonstrated the fast response of the as-fabricated sensors by in situ monitoring the SPR wavelength-shift and transmission intensity of Au/substrate SPR mode during the liquid flow test (Figure 3). And this novel plasmonic sensor has the potential on disposable chemical and biological sensors.

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[1] M. Svedendahl, S. Chen, A. Dmitriev, and M. Ka¨ll, Nano Lett.**9**, 4428 (2009)
[2] E. M. Larsson, J. Alegret, M. Ka1ll, and D. S. Sutherland, Nano Lett.7, 1256 (2007)

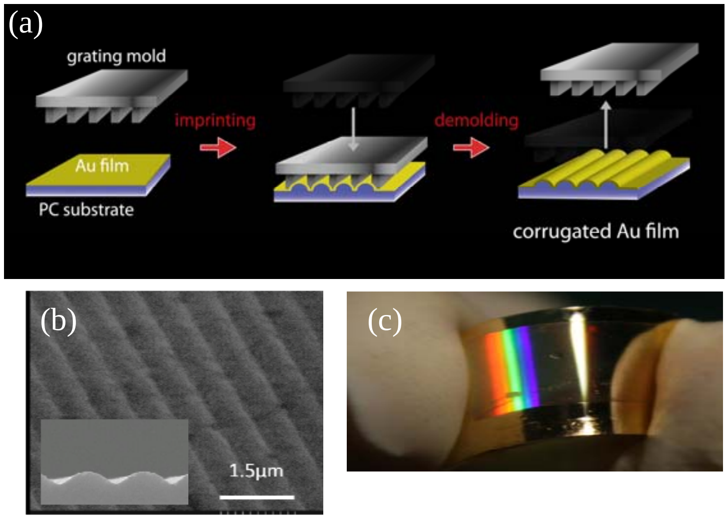

Figure 1: (a) Schematic representations of fabricating corrugated Au film by direct nanoimprint in metal. (b) SEM image of corrugated Au film. Inset: cross sectional SEM image. (c) Photographs of corrugated Au film. A highly flexible structure.

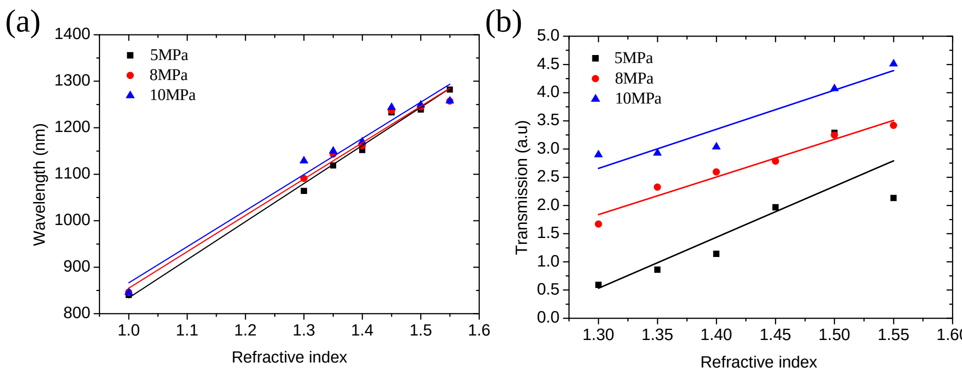

Figure 2: Linear calibration curves of index dependent (a) SPR wavelength of Au/sup mode (b) Transmission intensity of Au/PC mode

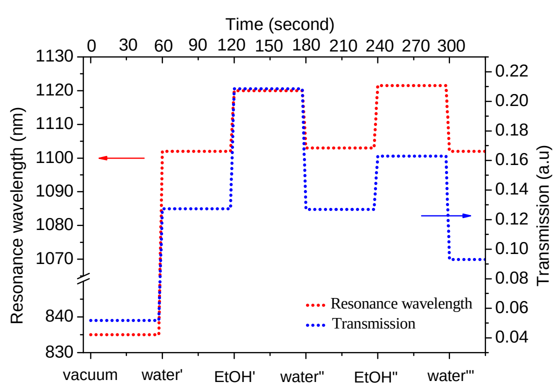

Figure 3: In situ measurement of SPR wavelength (Au/sup mode) and transmission intensity (Au/PC mode) when deionized water or ethanol solution were introduced into the flow cell.