Soft UV Nanoimprint Lithography designed Plasmonic Substrates for Bimodal Biodetection.

G. Barbillon[a], J.-F. Bryche[a,b], F. Hamouda[a], J. Ruscica[a], R. Gillibert[c], J. Moreau[b], M. Lamy de la Chapelle[c], M. Canva[b], B. Bartenlian[a]

[a] Institut d'Électronique Fondamentale - Université Paris-Sud, Orsay, 91405, France.
[b] Laboratoire Charles Fabry - Institut d'Optique Graduate School, CNRS, Palaiseau, 91127, France.
[c] Laboratoire de Chimie, Structures, Propriétés de Biomatériaux et d'Agents Thérapeutiques (CSPBAT) - Université Paris 13, Bobigny, 93017, France.
gregory.barbillon@u-psud.fr

Abstract

Soft lithography is well-known to be useful for biological applications. They are compatible with insulating support and with the necessity to obtain large area of nanostructures [1]. To do that, the soft UV-assisted Nanoimprint Lithography (UV-NIL) is used [2,3]. In this work, the fabrication of bimodal plasmonic substrates obtained by soft UV-NIL and reactive ion etching (RIE), is optimized in order to obtain large arrays (from some mm^2 to cm^2) of gold nanodisks on gold film. These samples allow two modes of optical characterization of biomolecular targets: the Surface Plasmon Resonance Imaging (SPRI), for quantification, and the Surface-Enhanced Raman Scattering (SERS) effect, for spectroscopic identification.

Firstly, the master mold is patterned (nanodisk arrays) by electron beam lithography (NanoBeam nB4) on a silicon substrate. RIE processes have been optimized to transfer the pattern in the Si master mold. Indeed, we demonstrated that the verticality of the hole walls has an effect on the fabrication of the PDMS stamps. The next step is the imprint process through the AMONIL resist with PDMS stamps. A bilayer AMONIL-MMS4 / PMMA 950K [2] is deposited by spin-coating on the gold film in order to remove the AMONIL resist after the UV curing and to obtain a good lift-off process. The imprint in AMONIL (Figure 1(a)) was performed with an EVG620 equipment using a mercury lamp at 365 nm wavelength. The etching processes of AMONIL and PMMA have been optimized to transfer the pattern. For this fabrication, the etching is stopped at the level of the gold film. Then, a gold layer (30 nm) is evaporated on this gold film, and the remaining PMMA/AMONIL bilayer is removed via the lift-off process. The gold nanodisks were obtained for diameters varying from 100 to 500 nm by step of 50 nm with a periodicity of 600 nm (Figure 1(b): example of nanodisks obtained by soft UV-NIL), and also for a periodicity of 400 nm with diameters varying from 100 nm to 300 nm. In order to valid our fabrication process, the samples were used to detect chemical molecules (here, Thiophenol molecules) by SPRI and SERS. The SERS signal is improved by a factor 10 compared to gold nanodisks directly on Si or glass substrates together with a good sensitivity for SPRI measurements.

References

[1] M. Cottat, N. Lidgi-Guigui, I. Tijunelyte, G. Barbillon, F. Hamouda, P. Gogol, A. Aassime, J.-M. Lourtioz, B. Bartenlian, M. Lamy de la Chapelle, Nanoscale Research Letters 9 (2014) 623.
[2] G. Barbillon, F. Hamouda, S. Held, P. Gogol, B. Bartenlian, Microelec. Eng. 87 (2010) 1001-1004.
[3] F. Hamouda, H. Sahaf, S. Held, G. Barbillon, P. Gogol, E. Moyen, A. Aassime, J. Moreau, M. Canva, J.-M. Lourtioz, M. Hanbücken, B. Bartenlian, Microelec. Eng. 88 (2011) 2444-2446.

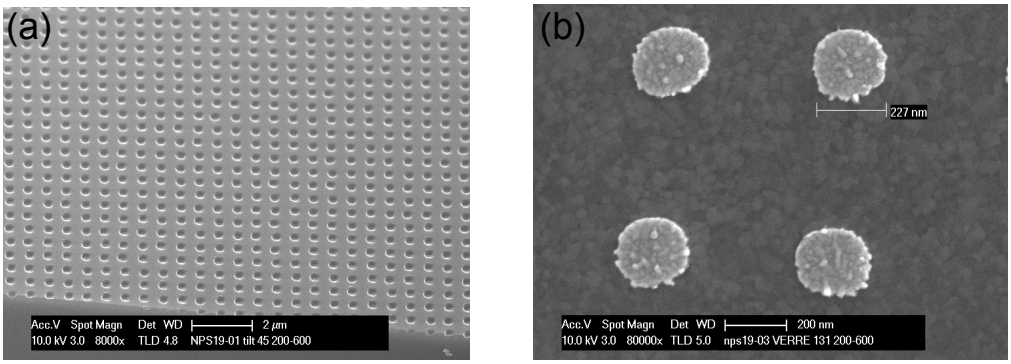

Figure 1. SEM images, the dimensions of the presented example are: diameter = around 200 nm, and the periodicity = 600 nm: (a) Imprint in AMONIL, and (b) gold nanodisks on gold film obtained by soft UV-NIL.