Enhanced Transmission through Gold Nanohole Arrays Fabricated by Thermal Nanoimprint Lithography for Surface Plasmon Based Biological Sensing

J. Martinez-Perdiguero, A. Retolaza, D. Otaduy, A. Juarros, S. Merino
Micro and Nano Manufacture Unit, Tekniker, Eibar 20600, Spain
jmartinez@tekniker.es

In this contribution we present nanohole arrays fabricated using thermal nanoimprint lithography integrated into a microfluidic device for detection of biological analytes using surface-plasmon-mediated enhanced optical transmission.

Surface plasmons are widely used in bioanalytical laboratories as label-free real-time method for molecular interaction studies. Commercial systems usually work in internal-reflection based *Kretschmann* configuration which requires a complicated optical setup. The non-classical extraordinary light transmission effect through nanohole arrays [1] can be used for surface sensing using miniaturizable collinear optics. In addition, micrometric-size footprints allow for multiplexing with high spatial resolution.

Typically, manufacturing of nanohole arrays is made by focused ion beam or electron beam lithography techniques which are not suited for mass production. However, we fabricated the arrays by nanoimprint lithography which is a low-cost, high resolution method with a much larger throughput [2]. Up to 49 different nanohole arrays with different hole diameters (100-250 nm) and periodicities (450-800 nm) with an average footprint of 25 um^2 were patterned in a silicon master using standard electron beam lithography. The master stamp was used repeatedly to transfer the structures via hot embossing to mr-I7010R resin spin-coated over glass wafers. After demolding, the residual layer was etched with oxygen plasma, a Ti/Au (5/60nm) layer was deposited with e-beam sputtering and the resin lifted off. A typical array SEM image is shown in Fig 1.

These nanohole arrays were integrated in a microfluidic cell and the transmission spectra of white light were recorded. Modulation of the incident light was measured which does not correspond to that of the classical aperture theory [1] (see Fig. 2a). A sensitivity of 300 nm/RIU was achieved using solutions of known index of refraction and measuring the shift of resonance peaks (Fig.2b).

Biofunctionalization of the surface was performed with thiolated probes or protein immobilization via carboxylated SAMs. Detection of analytes such as prostate-specific antigen (PSA), mouse immunoglobulin or cancer biomarkers such as TNF-alpha was achieved.

[1] T.W. Ebbesen, H.J. Lezec, H.F. Ghaemi, T. Thio and P.A. Wolff, Nature 39, 667 (1998)
[2] L. J. Guo, Adv. Mater. 19, 495 (2007)

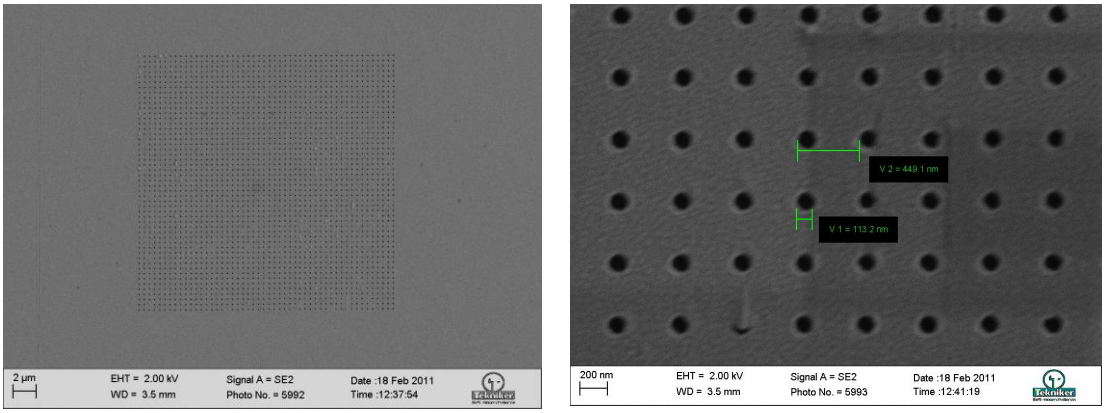

Figure 1: SEM images of a 50x50 gold nanohole array fabricated with thermal nanoimprint lithography (hole diameter 115nm, periodicity 450nm).

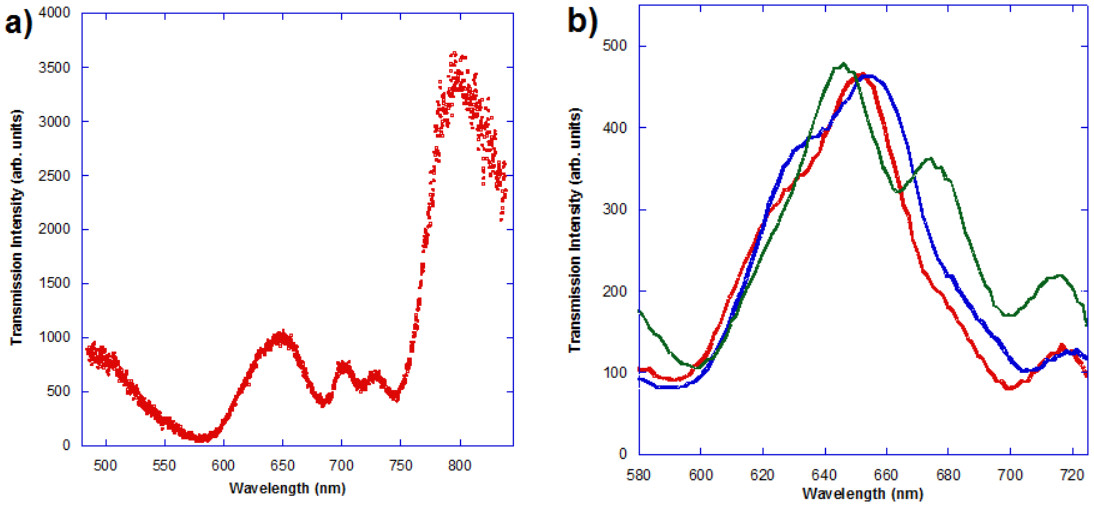

Figure 2: a) Normalized transmission spectrum of a gold nanohole array (that of Fig. 1) in air. b) Resonance peaks shift using sucrose solutions of known index of refraction: green line n=1.333, λ_{peak}= 645.7 nm; red line n=1.356, λ_{peak}= 651.2 nm; blue line n=1.381, λ_{peak}= 656.1 nm.