NANO-ADDRESSING BIOMOLECULES FOR HIGH SENSITIVITY BIODETECTION

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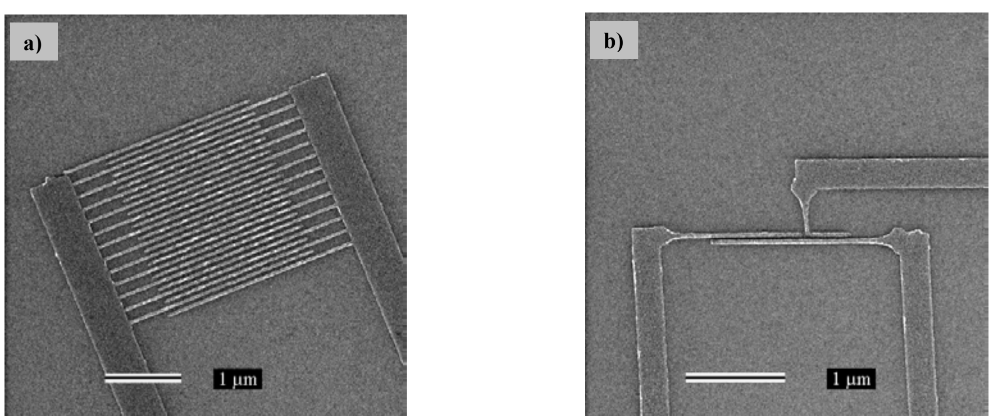
In Nanosciences, connecting an individual nano-object remains a technological bottleneck. The way nano-objects can be coupled to the micro and macroscopic environment without loosing their intrinsic properties is the main issue of so-called "NanoAddressing". In LAAS-CNRS, the "Nano-addressing/Nanobiotechnologies" group, created two years ago, develops and validate new concepts for achieving smart planar addressing at the nanoscale. Our scientific activity is declined among three axes corresponding to the various modes of interaction with the nanosystem : Electrical addressing, Mechanical addressing and Optical addressing. After a brief overview, the presentation will be focused on the problematic of electrical nano-addressing.

We will present recent results on the fabrication of nanoelectrodes using high resolution electron beam lithography and their possible low cost replication using Nano-Imprint Lithography. We first demonstrate how very high-resolution electron beam lithography (EBL) can be used to reproducibly fabricate sub-10 nm planar nano-electrodes onto silicon substrates (1). Several approaches are investigated in order to connect single or multiple molecules. Though EBL is an extremely powerful technique in term of ultimate resolution, it cannot be considered as an industrial process for direct writing at high throughput. We have thus developed original Nano-Imprint Lithography processes enabling by simple polymer molding the duplication of these kind of nanodevices.

The final part will describe the activity around the electrical addressing of biomolecules for sensing purposes. Nano-electrode based devices were used to achieve the electrical detection of gold colloids functionalized biomolecules. We show that binding events can occur in electrodes gaps and lead to a drastic modification of the electrical transport through nanoelectrodes. Using this method, we have demonstrated the detection of single gold particles even in solution and confirmed the very high sensitivity of our devices. This approach was successfully applied to the electrical detection of antibodies interactions on interdigitated electrodes arrays. These results show clearly the high sensitivity and compatibility of this approach towards the fabrication of effective biosensors for ultra sensitive immuno-assays (2).

[1] F.Carcenac, L.Malaquin, C.Vieu, Microelectronic Engineering 61-62, 657 (2002)
[2] L. Malaquin, C. Vieu, M. Genevieve, F. Carcenac, Y. tauran, V. Leberre, E. Trévisiol, to be published in Applied Nanoscience (2004)



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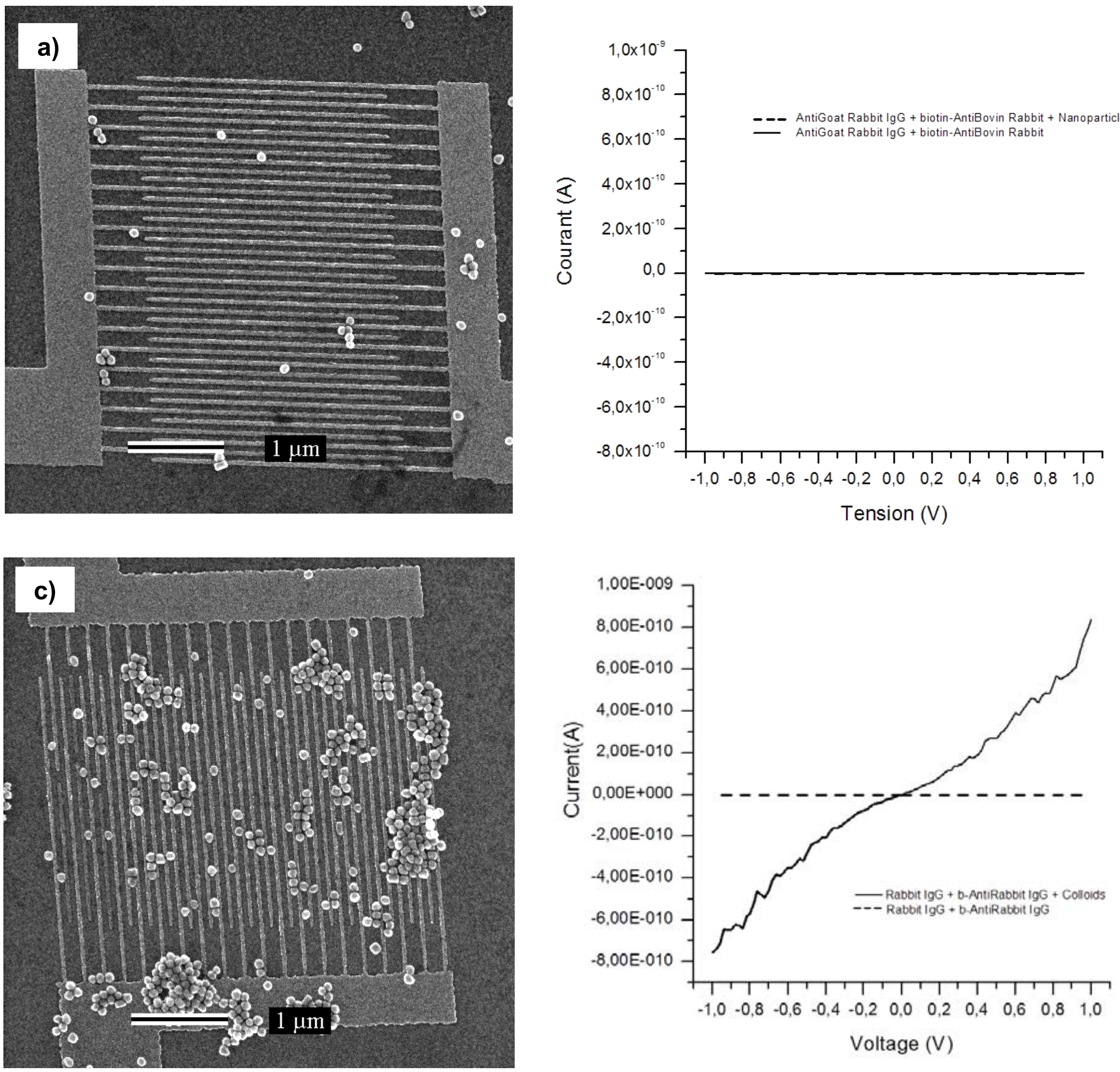
SEM images of a 40nm line and space interdigitated electrodes array (a) and 3 electrodes device with 20 nm gaps obtained after high resolution EBL and Au (20nm) lift-off



The Nanoimmunoassay : a),b) Control experiment : a) SEM image of an interdigitated nanoelectrode array (electrodes width: 35nm, gap: 65nm) obtained after the deposition of an Anti Goat Rabbit IgG (B), incubation with a biotin labelled Anti Bovin Rabbit IgG (A) and interaction with a colloidal solution. b) corresponding I(V) characterization. The two electrical responses before and after colloidal labelling are super-imposed but cannot be distinguished. The vertical scale has been intentionally chosen for allowing direct comparison with the positive experiment shown in figure 7d). **c),d) Positive experiment :** Same experiments carried out by replacing IgG (B) with an AntiRabbit Donkey IgG (C) exhibiting strong affinity with IgG(A). The SEM image c) shows a density of colloids close to 10 particles/µm². d) I(V) measurements performed before and after colloid labelling.