METHODOLOGY FOR CONTACT FABRICATION TO NANOMETRE-SIZED MATERIALS USING A DUAL-BEAM FOCUSED ION BEAM SYSTEM

Francisco Hernández-Ramírez[1], *Jorge Rodríguez*[1], *Anna Vilà*[1], *Albert Romano-Rodríguez*[1], *Juan Ramón Morante*[1], *Mohamed Abid*[2], *Sima Valizadeh*[3]
[1]*EME (CEMIC & CeRMAE), Departament d'Electrònica, Universitat de Barcelona, c/ Martí i Franqués, 1; E-08028 Barcelona, Spain*
[2]*Laboratoire de Physique des Matériaux Nanostructurés, École Polytechnique Fédérale de Lausanne, EPFL; CH-1015 Lausanne, Switzerland*
[3]*Ångströmlaboratoriet, Universitet Uppsala, Lägerhyddsvägen 1; SE-751 21 Uppsala, Sweden*
fhernandez@el.ub.es

In order to fully benefit from the properties of nanometre-sized materials in their use as building blocks in Nanoscience and Nanotechnology, the exact knowledge of their properties is required. Among the different parameters (structural, chemical, electrical, optical, …) and with the view of their use in the fabrication of electronic devices, the electrical properties become the important issue. These properties are not easy to obtain at the level of individual nanometre-sized materials or of few of their agglomerates because of the difficulty in fabricating electrical contacts that allow to access the materials with a resolution in the order of tens of nanometre and that can be produced ad-hoc.

In this work we present a methodology for the fabrication of electrical contacts that fulfils the characteristics indicated above, i.e., that has the required resolution, that can be used for different kinds of materials and structures and that can be performed on demand and on prespecified regions. The methodology is based on the use of Focused Ion Beam (FIB) and more concretely of a dual-beam FIB for the deposition of metallic stripes (in our case Pt) via decomposition of a metalorganic compound (here PtC_9H_{16}) by either the ion (Ion beam induced deposition, IBID) or the electron (electron beam induced deposition, EBID) beams. In both cases large contamination with carbon is observed, which is responsible for the higher resistance of the deposited platinum compared to metallic platinum. IBID gives rise to a higher deposition rate than EBID and to a Ga contamination, which is responsible that the resistivity of IBID deposited Pt is only 100 times that of metallic platinum, while it is a factor of 10^5 for EBID. However IBID damages or modifies the nanomaterial in a much stronger way than EBID does. In spite of this increased resistivity, in both cases the metallic stripes can be used as an ohmic contact.

For this reason the methodology of contacting the nanomaterials is based on the use of EBID Pt on top and in the vicinity of the nanomaterial under study and on the use of IBID Pt to reach the Ti/Ni/Au metallic pads, defined by standard photolithography on oxidised silicon wafers, from the end of the EBID Pt stripe. The minimal width which we have successfully deposited using this technique has been of the order of 120 nanometre [1], although a reduction is envisaged. Several configurations, from two to four terminals, can be produced in this way, which allows the realisation of different types of electrical measurements. Figure 1 shows the result of fabricating four contacts to an individual nanowire of In_2O_3, with a diameter of about 400 nm, for the realisation of 4 point probe measurements. Figure 2a corresponds to the fabrication of two contacts on an agglomerate of WO_3 nanoparticles using a similar process as for figure 1. The corresponding electrical response, identified as the change in resistance, in the presence of NO_2 is plotted in figure 2b, which shows the feasibility of the method in obtaining electrical parameters from the samples. Several other examples of contact fabrication to electrically access nanomaterials will be presented.

This work has been partially supported by the EU through the project NANOS4 of the VI FMP and through the Transnational Access to Research Infrastructure. F.H.-R. is indebted to the Spanish Ministry of Education (MEC) for the FPU grant.

References:

[1] F. Hernandez-Ramirez et al, presented at the TNT2004 conference (2004).

Figures:

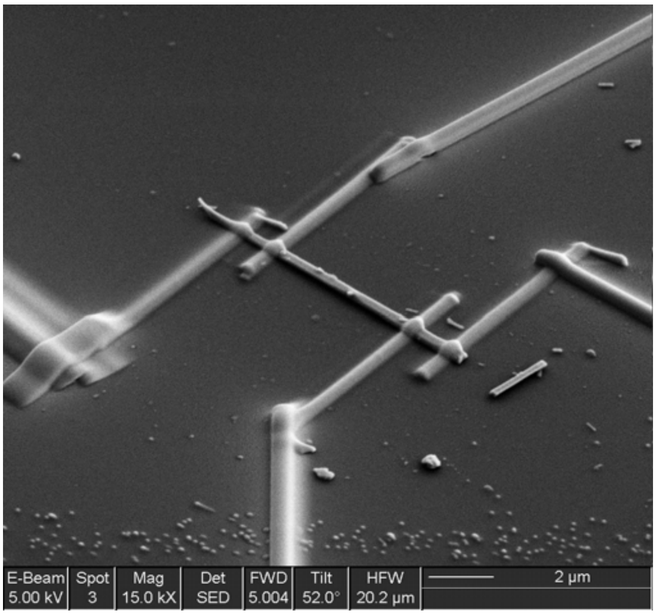

Figure 1: SEM image of the four contact fabrication on an In_2O_3 nanowire. The contacts on top of the nanowire are fabricated by EBID, the larger ones are fabricated by IBID.

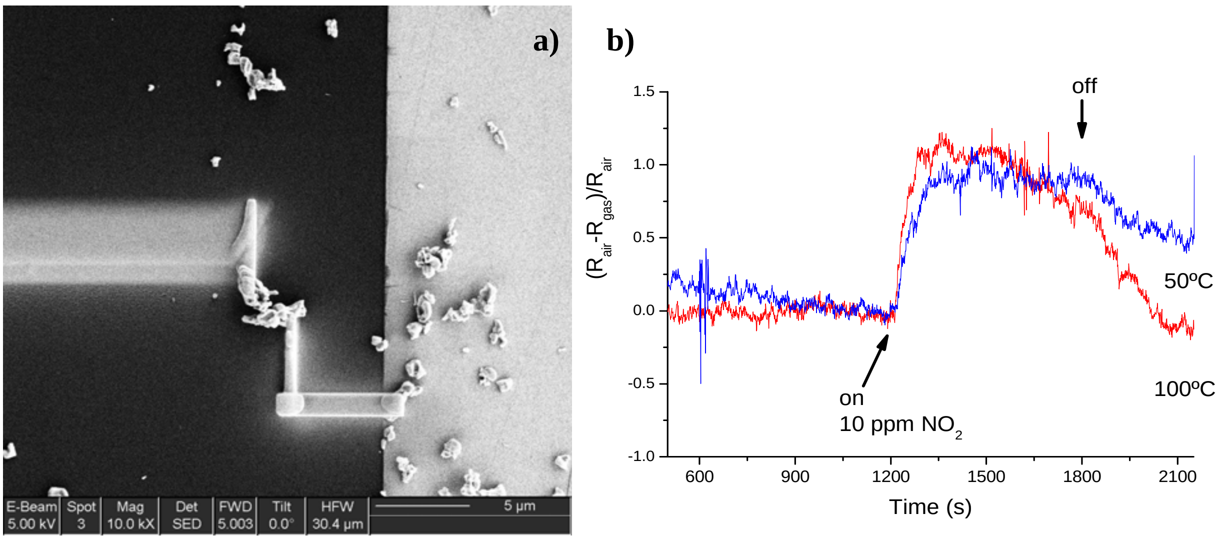

Figure 2: a) Fabrication of two contacts on an agglomeration of WO_3 nanoparticles and b) gas response of the device.