CHEMICAL AND ELECTRICAL CHARACTERIZATIONS OF DEPOSITS ELABORATED BY FOCUSED ION BEAM ASSISTED DEPOSITION

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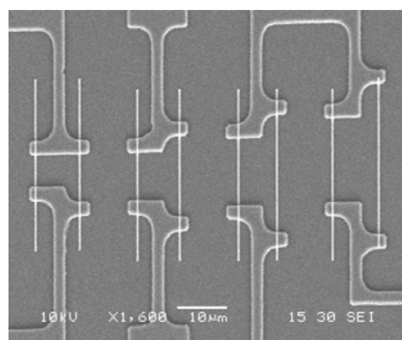
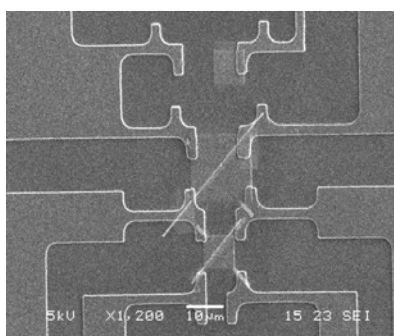
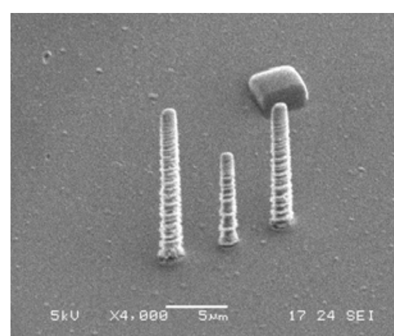
Scaling down in microelectronics leads to a larger complexity in the devices processing. In the failure analysis, a tool able to modify the interconnections network of a chip in order to validate the circuit design is required. In the same way, nanotechnologies need thinner and smaller electrodes for nanostructures studies.
Focused Ion Beam (FIB) systems have the ability to locally mill by ion sputtering or deposit materials via a process called Focused Ion Beam Assisted Deposition (FIBID). This process is a maskless direct writing technique which allows to deposit metallic, semi-conducting or insulating patterns in a single proceeding step.
Our experimental setup is a cross beam system coupling a Focused Ion Beam, a Scanning Electron Microscope (SEM) and a Gas Injection System. The two beams are focused on the same point. This setup benefits from real time simultaneous FIB machining and SEM non-destructive non-contaminating high resolution imaging.
We present the chemical and in-situ electrical characterizations of structures elaborated by FIBID.
Tungsten wires have been obtained from $W(CO)_6$ precursor heated from 40 to 60°C. The linewidth can be as low as 120nm. These wires display a metallic behavior, a low resistivity (only 20 times the bulk one) and a good stability to atmosphere exposure.
As for insulator deposition, silicon oxide structures from PMCPS (Penta Methyl Cyclo Penta Siloxane) precursor have been patterned. The deposition is rapid, uniform and conform to the substrate surface morphology. We show also structures exhibiting high aspect ratios. Chemical analyses demonstrate an oxygen sub-stoichiometry and a gallium contamination close to 10%at. Electrical measurements have been carried out on a test structure entirely drawn by FIBID, which consists in two crossing tungsten wires separated by one insulating layer. We have measured a leakage current of 5nA at 3V and a breakdown field of 0.6MV/cm.



Height FIB-deposited tungsten wires 30µm-long, 200nm-wide, 100-thick connected between Al electrodes



Test structures consisting in two tungsten wires (as electrodes) which are insulated by the SiO_x film



SiOx structures with high aspect ratio deposited in various times (4, 2 and 3 min from left to right)