Gas sensing nanodevices based on individual tin oxide nanowires: fabrication strategies using electron- and ion-beam-technologies and gas sensing characteristics

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Tin oxide (SnO_2) has been used for more than 30 years as active material in the fabrication of resistive solid state gas sensors that are employed in the detection of different gases. Although commercial gas sensors based on this material exist already for years, some questions about the sensing mechanisms are still open. It has been proposed that the use of one-dimensional SnO_2 nanostructures, like nanowires, could help in answering part of them, but the fabrication of electrical contacts to them are still difficult.

In this paper strategies for the fabrication of electrical contacts to individual tin oxide (SnO_2) nanowires using electron- and ion-beam-technologies in-situ in a dual-beam focused ion beam machine (FIB) are presented. For this, monocrystalline SnO_2 nanowires have been dispersed on different SiO_2/Si substrates with prepatterned metallic pads. Both electron- and ion-assisted deposition of a platinum alloy inside a FIB machine with nanometre resolution is used to connect the nanowire to the pads. The electrical investigation of the resulting structure allows the characterisation of the nanowires and of the metallic contacts and allows to choose the best methodology and configuration for contacting these nanowires. Equivalent circuits for the nanowires and the contacts have been proposed and the parameters fitted to the experimental values. The methodology has been extended and applied to other nanomaterials, like carbon nanotubes, metallic nanowires and nanoparticles.

The contacted nanowires have been employed as gas nanosensors and have been electrically characterised in the presence of different gas atmospheres and temperatures, the most sensitive being those with the smaller radius. Values as low as 5 ppm of CO have been detected. The gas behaviour towards the different gases will be discussed taking into account the contacting methodology employed.