Electrical properties of ZnO single nanowires contacted by FIBID and EBL

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Abstract

Semiconductor nanowires are used for building electronic devices like chemical or biological sensors, nwFETs, memories, light emitting diodes. In order to properly use the nanowires for such applications, the understanding of the transport properties in this kind of nanostructures becomes more and more important. To our knowledge, there is no evidence in the literature of the electrical properties of single zinc oxide nanowires grown electrochemically.

In this paper we investigate the electrical properties of ZnO nanowires grown electrochemically by the template method [1]. Contacting a single nanowire was a barrier that has been overcome using different lithographic techniques. Interdigitated electrodes made from different materials (Pt, Al) were deposited on Si/SiO_2 substrates using photolithography combined with thermal vacuum evaporation. The contact between the nanowire and the interdigitated electrodes was made by e-beam lithography (EBL) and by focused ion beam induced deposition (FIBID) of platinum stripes.

The quantitative analysis of the current-voltage measurements gave us information about the intrinsic parameters of the ZnO nanowires such as conductivity, mobility or concentration of impurities. By fitting the curves using the metal-semiconductor-metal (M-S-M) model [2] the effective potential barrier was computed. A comparison between the two methods of contacting the semiconducting nanowires was made in order to select the one that is most suitable for being used in applications.

Our results are comparable with electrical measurements made on ZnO nanowires prepared by other methods such as high-temperature thermal evaporation process [3], vapor-liquid-solid process [4, 5] or electric field assisted nucleation [6].

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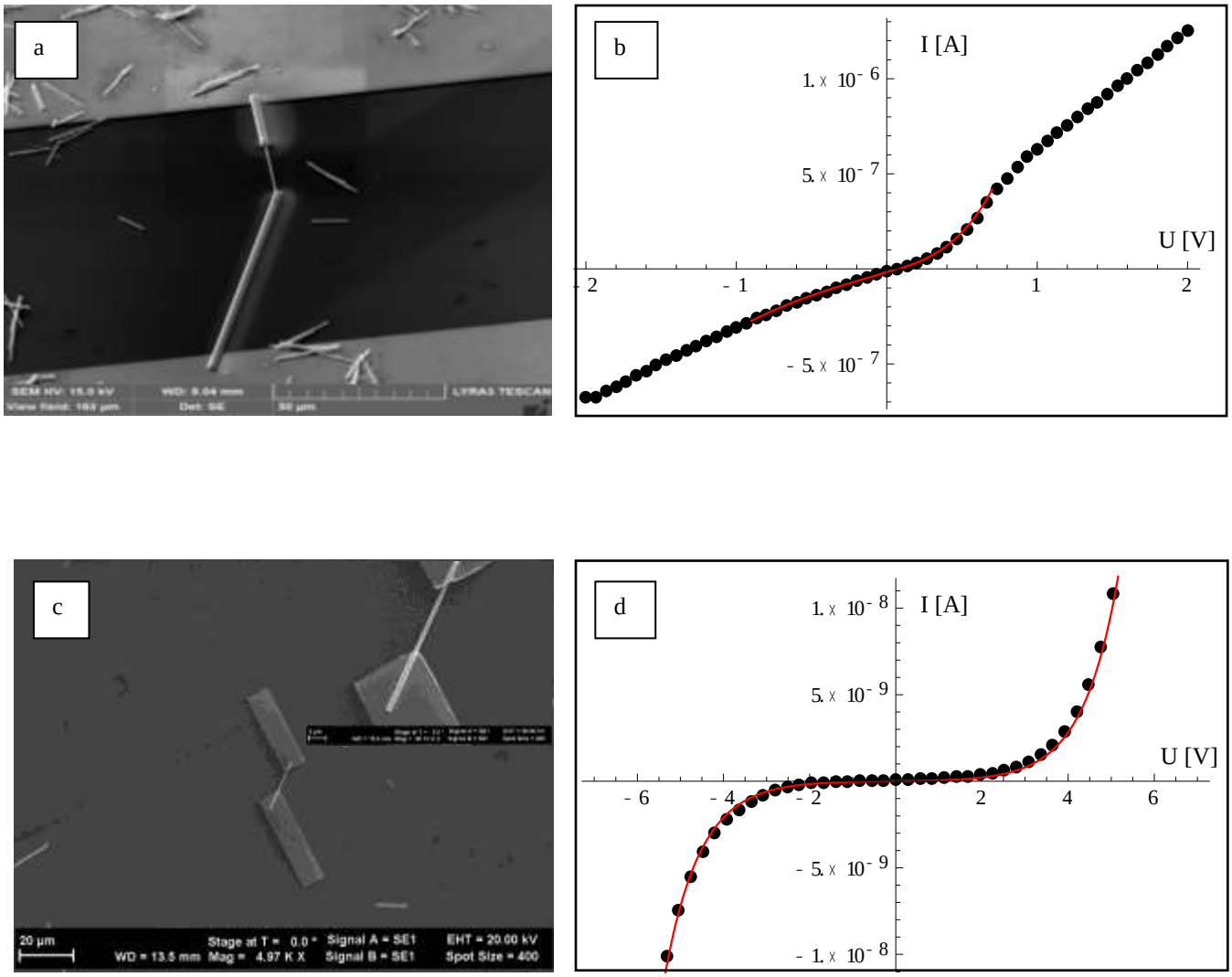
Figures



SEM images of a single ZnO nanowire contacted using FIBID (a) and EBL (c) and their corresponding electrical characteristics (b) and (d)