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Modulation of the electrical conductivity of a ZnO nanowire by surface effects

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ZnO semiconductor nanowires are widely used for applications in the fields of sensors, photovoltaic [1] and piezoelectric energy harvesting [2]. Depending on the manufacturing technique chosen, the doping level of the ZnO nanowires can vary by several orders of magnitude [3]. The electrical conductivity of the material is therefore very dependent on the choice of manufacturing method. However, it is possible in post-processing to modulate this electrical conductivity to improve the sensitivity of a sensor or the energy conversion rate of a piezogenerator using surface treatment technologies.

Intrinsically, there are traps on the surface of the material that are free electron acceptor levels in the band gap. These surface traps have a surface density that can vary according to the heat treatments used and according to the radius of the ZnO nanowire [4]. Extrinsically, creating a contact between ZnO and other materials can also allow modulating this electrical conductivity. We can use either a nanowire coating technique as for example with a semiconducting polymer, or a localised metal deposition as in Figure 1 illustrating the case of gold nanoclusters deposited on the side face of ZnO nanowires inside a UV sensor device [5].

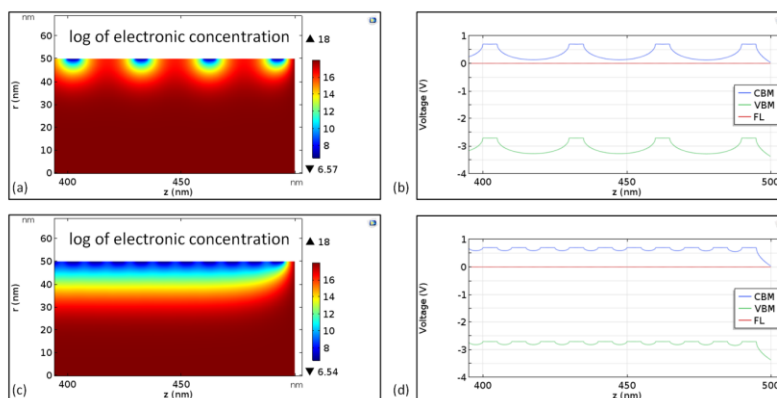


Figure 1 : Depletion area and energy levels along the ZnO nanowire lateral surface with Au clusters distance of 30 nm (a) and (b) or 10 nm (c) and (d).

These different possibilities make it possible to modulate the electrical conductivity of ZnO nanowires to improve their desired performances.

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