# Functional Materials

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## Structural and Morphological Characterization of Doped ZnO Nanowires

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Zinc oxide is a very interesting and promising material due to its functional properties: it is a piezoelectric wide band gap semiconductor which can be synthesized in a wide variety of nanostructures, such as nanowires, nanobelts, nanopods, nanoparticles. It is therefore an ideal candidate for the development of innovative miniaturized devices ranging over the field of nanotechnology [1].

The doping of ZnO with other chemical elements is crucial in order to control and to modulate its physical properties: p-type conductivity, band-gap tuning, enhanced piezoelectricity [2,3]. Some authors report on the doping of ZnO with transition metals as a way to achieve room temperature ferromagnetism, making ZnO a suitable material for spintronic applications [4].

In this work we report on the structural, chemical and morphological characterization of ZnO nanowires doped with Cr or with Mn by means of Field Emission Scanning Electron Microscopy (FESEM), Transmission Electron Microscopy (TEM), X-ray Diffraction (XRD) and X-ray Photoelectron Spectroscopy (XPS).

The synthesis of the doped nanowires was carried out through the hydrothermal method in a two-step synthetic approach. At first the substrates (silicon wafers) were coated with a thin film of oriented crystalline ZnO. This film acts as a seed layer for the further nucleation and growth of ZnO nanowires. The wire growth was carried out in a solution at 88°C for 1h, using zinc nitrate as the source of zinc, and chromium or manganese nitrates in order to introduce the dopants into the ZnO oxide crystalline structures.

The morphology of the samples was initially characterized by Field Emission Scanning Electron Microscopy: the aspect ratio, vertical alignment of the nanowires and the homogeneity of the samples were evaluated. Energy dispersive X-ray spectroscopy (EDX) and XPS were performed in order to reveal the presence of the dopants in the nanostructures, both in case of Cr and Mn doping. Further investigation of the structure of the doped nanowires was carried out by Transmission Electron Microscopy: high-resolution TEM imaging and selected area electron diffraction (SAED) of Cr-doped and Mn-doped samples were performed in order to analyze the crystalline structure of the nanowires, their orientation and the possible presence of defects due to the dopants.

The structural properties of the doped nanowires were finally correlated with their functional properties, showing the role of the dopants.

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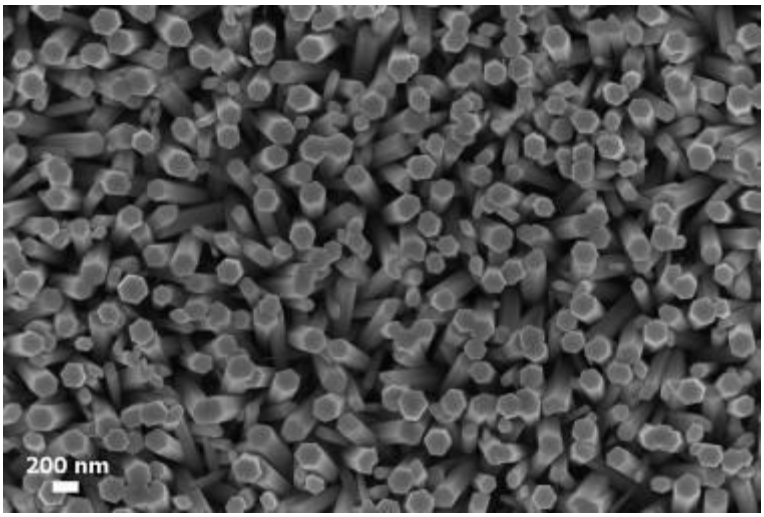


**Figure 1.** FESEM image of Cr-doped ZnO nanowires (top view)

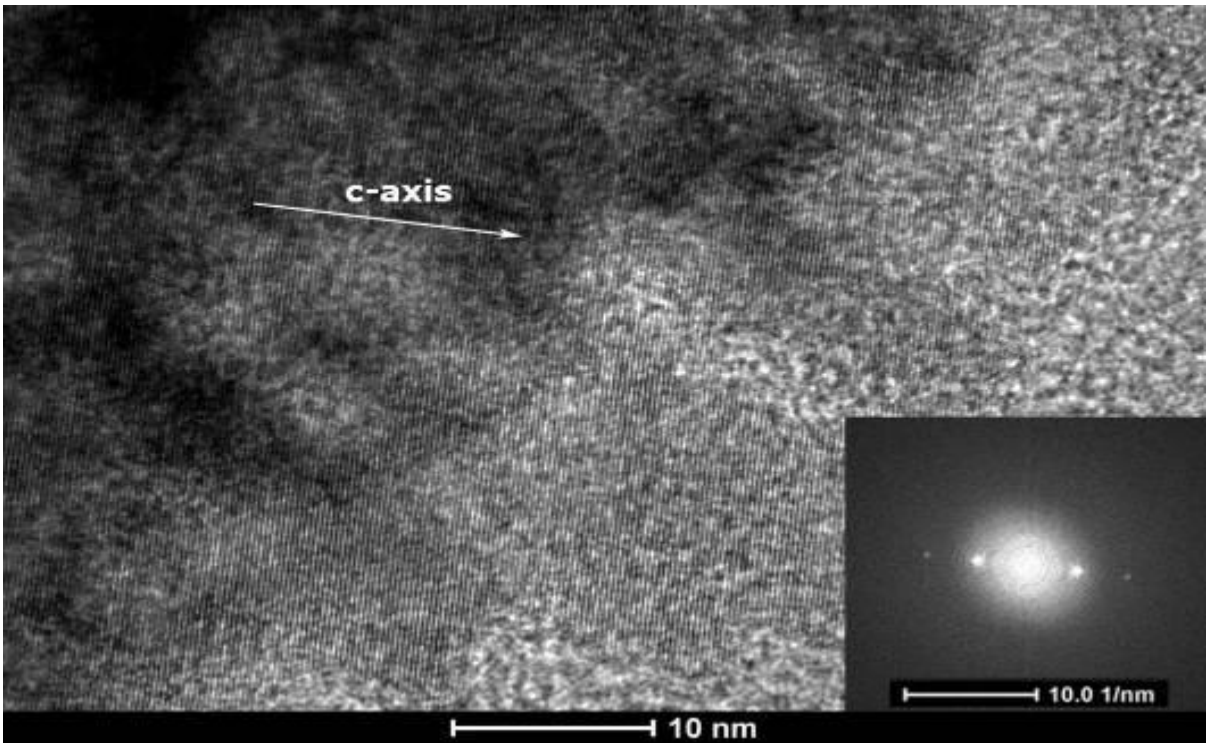


**Figure 2.** Bright field TEM image of a single Cr-doped nanowire. Inset: FFT of the image showing that the nanowire grows along the (002) direction.