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Synthesis and multi-scale characterization of Zinc Oxide Nanowires

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For several decades, Zinc oxide (ZnO) has been one of the most promising lead-free piezoelectric materials known for its piezoelectric properties for energy harvesting. This green material can be a substitute for materials containing toxic elements such as lead.

One-dimensional (1D) ZnO nanostructures, such as nanowires (NWs), have been widely studied by many teams around the world in recent years, as they can be synthesized using a variety of methods, including hydrothermal synthesis. This method has the advantage of having a low carbon footprint, is more environmentally friendly as it is realized at low temperature (<100°C) and it is simple and inexpensive.

In this research activity, the ultimate aim is to manufacture materials on several scales, namely thin films and ZnO NWs with a strong crystal structure and vertically oriented microstructure. We have studied the contribution of ZnO seed layer, deposited by sputtering, on the growth of NWs.

To optimize the seed layer required for vertical nanowire growth, several parameters were studied, including the Argon/O2 ratio and the deposition temperature (in-situ, ex-situ).

The resulting seed layers and NWs were studied by environmental scanning electron microscopy (eSEM), X-ray diffraction (XRD) and atomic force microscopy (AFM). The eSEM analysis shows the columnar structure by the section and the grain structure by the surface of ZnO seed layers as well as the hexagonal structure of the NWs . The topography of ZnO seed layers and NWs was observed by AFM.

The electrical performance of the resulting structure was also studied: The I-V curves show non-linear electrical characteristics, confirming the formation of Schottky contacts.

In fine, a ferroelectric behavior observed for ZnO, known as a non-ferroelectric material, was studied by ss-PFM (switching spectroscopy Piezoresponse Force Microscopy) and cKPFM (contact mode Kelvin probe force microscopy).