

NOVEL NANOSTRUCTURES GROWN BY ELECTROPHORETIC DEPOSITION USING Si SUBSTRATES WITH LOW RESISTIVITY

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During the last years, the activity and interest in the science and technology of nanostructures have increased exponentially. The use of nanoparticles, nanowires and other nanostructures in the manufacture of different (such as photovoltaic, electronic, optoelectronic, photonic, biomedical) devices is becoming increasingly important as a result of the benefits provided by the nanoscale. In particular, the nanostructures of transparent conductive oxides (TCO's) and wide bandgap semiconductors (such as ZnO), stand out in opto and microelectronics mainly because they are nanometric building blocks that may enable the fabrication of, respectively, electrical interconnections with relative simplicity and active optoelectronic elements in transparent circuits.

Deposition of nanoparticle (NP) suspensions onto different substrates is a widely used method to produce nanostructured coating. The liquid phase deposition of precursor solutions or NP dispersions offers several advantages, such as simple equipment, mild deposition conditions, and flexibility in tuning the properties of the deposition. Among the manufacturing techniques of different nanostructures, Electrophoretic Deposition (EPD) arises as a reliable process at relatively low temperature and cost.

Because the choice of the type of substrate has a profound influence both on the deposition parameters and on the properties of the coating, we report in this work the self-assembled growth (without a sacrificial template) of ZnO nanowires on commercial Si wafers with different resistivities. In order to find the best way to obtain homogeneous and reproducible deposits, a careful design of the cell was also carried out.

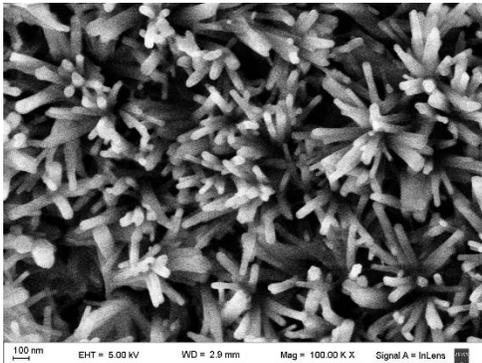


Figure 1 – SEM image of ZnO nanowires grown by EPD, using a p-type $\langle 100 \rangle$ Si substrate with $\rho = [10\text{-}20 \text{ m}\Omega\text{-cm}]$, applying 40V during 1 hour with 7.5 mm separation between electrode and substrate.

The novel nanostructures (figure 1) growth was performed at room temperature by EPD from a ZnO NP colloidal suspension. The size of the NPs obtained was estimated from absorbance and photoluminescence measurements, which yielded an average diameter of 5 nm with a narrow size distribution, between 4 and 7 nm. Also measurements made using transmission electron microscopy (TEM) verify this value for the size of the nanoparticles. The electrical potential around a spherical nanoparticle of ZnO, such as those synthesized in this work, was calculated using a program written in MATLAB.

The obtained ZnO nanostructures are characterized by scanning and transmission electron microscopy, energy-dispersive X-ray spectroscopy, X-ray diffraction and photoluminescence spectroscopy.

We also discuss the influence of the conductivity of the substrate and the voltage used in deposition on the quality and morphology of the obtained nanostructures.