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MS-1-P-3415 Synthesis and Electron Microscopy Characterization of Non-stoichiometric Tin Oxide Structures

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Nanomaterials have attracted the attention of researchers in the recent past due to their interesting properties. Moreover, there is a wide applicability of these materials in several areas of knowledge, for example, chemicals sensors, solar cells and microelectronic devices. However, in order to use these materials in devices it is very important to have a deep morphological and structural characterization of materials and electron microscopy techniques are important tools for these characterizations.

In this work, we used a carbothermal evaporation method to obtain tin oxide structures. By controlling the oxygen amount inside the furnace it was possible to grow structures in different oxidation states; i.e. SnO_2, Sn_3O_4 and SnO. The samples were characterized by scanning and transmission electron microscopy, X-ray diffraction and electrical measurements. SEM characterization showed that SnO material is composed by nanobelts with spheres at their extremities and micro discs (which can be separated by sedimentation) while Sn_3O_4 and SnO_2 materials are composed of nanobelts. TEM and SAD characterization showed that all synthesized materials are single-crystalline and SAD patterns in different zone axis enabled the determination of the growth direction of each material. Based on these results, it was possible to propose that SnO nanobelts grow following a self-catalytic vapor-liquid-solid (VLS) mechanism and Sn_3O_4 and SnO2 nanobelts grow by a vapor-solid (VS) process. The growth mechanism of discs are not completely known, but is related to the solidification of SnO vapor. While SnO_2 is a well-known material in literature, there are only few works on SnO and Sn3O4 structures. Based on it we also studied the sensor response of materials to reducing and oxidizing gases and it was possible to correlate the sensor mechanism of materials with the exposed planes of structures.

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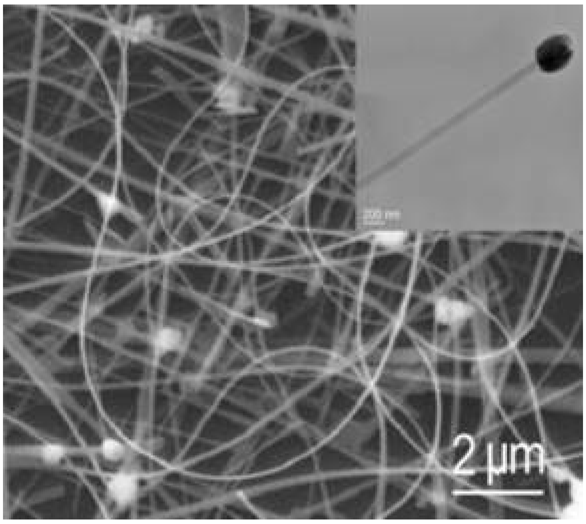

Fig. 1: SEM image of SnO nanobelts. In the inset there is a TEM image of a single belt.

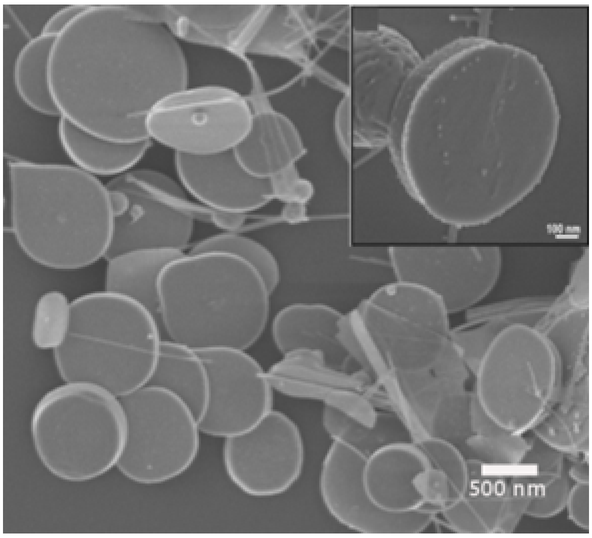

Fig. 2: SEM image of SnO microdiscs. In the inset there a SEM image of a single disc.

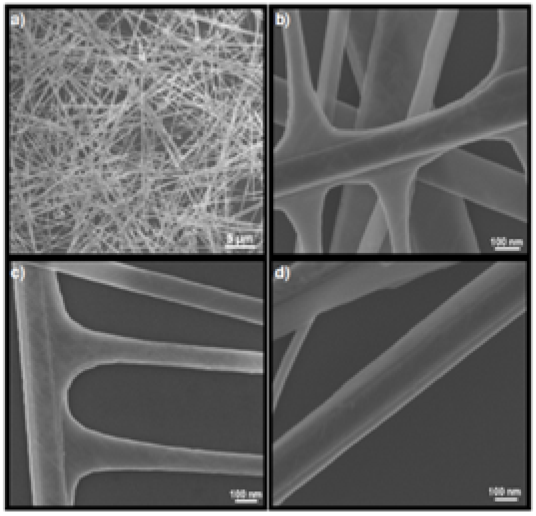

Fig. 3: a) SEM general view of Sn_3O_4 nanobelts. b-d) Details of Sn_3O_4 nanobelts.

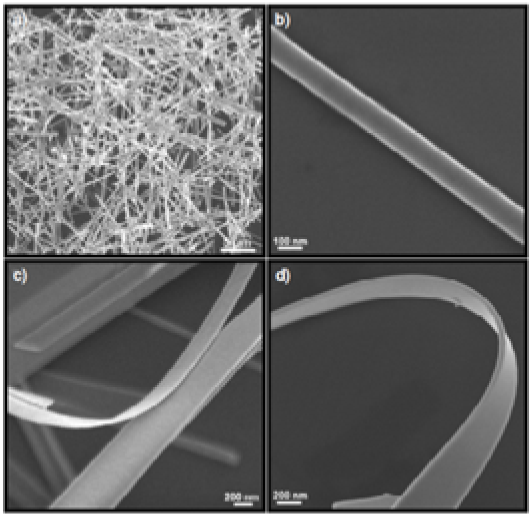

Fig. 4: a) SEM general view of SnO_2 nanobelts. b-d) Details of SnO_2 nanobelts.