FORMATION AND STRUCTURE OF TUNGSTEN OXIDE NANORODS

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Among the different metallic oxide investigated for their gas sensing properties, tungsten trioxide has shown good sensitivity towards various gases[1-6]. However sensing devices with WO_3 as sensing material suffer of a lack of selectivity. Various solutions have been proposed to improve the speed of sensing response and to enhance the selectivity[7-9]. Recently thin nanostructured WO_3 films have been tested. Due to their large surface area to volume ratio they exhibit good sensitivity depending on the grain size[10,11]. However in conventional WO_3 thin films the average grain size exceeds the thickness of the surface space charge layer, so the electrical conduction is mainly controlled by the carriers transport across the boundaries between grains.

An alternative way seems to be in a sensing monocrystalline material with nanometric dimensions. Our objective is to fabricate nanosized tungsten oxide rods and to test their sensing properties under gas adsorption. In this work, we focus on the formation, the morphology and the crystallography structure of tungsten nanorods.

The tungsten oxide nanorods were grown by vapor transport from a WO_3 layer onto a substrate (Al_2O_3, SiO_2, Mica). The nanorods growth was controlled by the temperature gradient between the WO_3 layer and the substrate. Their morphology was investigated by AFM and their structure by TED and TEM. The nanorods grew parallel to the substrate, they are several microns long, their width varies in a range of 50-150 nm and their thickness in a 10-20 nm range (Fig. 1).

The nanorod structure was determined by TED. The diffraction patterns consist of spots elongated in a direction perpendicular to the long axis. Their analysis indicates that nanorods have a monoclinic structure corresponding to $W_{18}O_{49}$ (a=18.3 Å, b=3.79 Å, c=14.04 Å, β=115.2°). This structure results of a formation of shear planes in a non-stoichiometric tungsten trioxide phase[12]. The nanorods axis is parallel to the b axis and the plane (b,c) is parallel to the substrate surface. High resolution electron micrographs show lines parallel to the nanorod axis which image the shear planes.

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Figure:

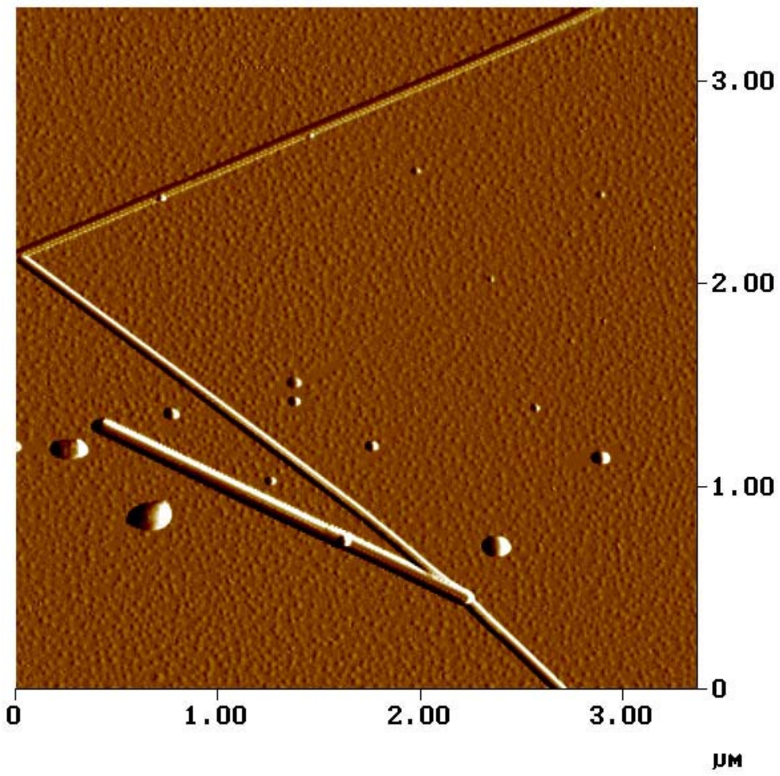

Figure 1 : example of tungsten oxide nanorods grown on mica substrate.