CHARACTERIZATION OF SiC NANOWIRES OBTAINED VIA COMBUSTION SYNTHESIS

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1. Introduction

Crystalline form of silicon carbide was found by Henri Moissan in the Diablo Canyon iron meteorite in 1905 [1]. Since then it has gained more and more attention due to its unique physical properties which are high hardness, large thermal conductivity, large energy band gap and high saturation velocity [2, 3]. Thus, SiC can be used in high-frequency and high-temperature electronics [4].

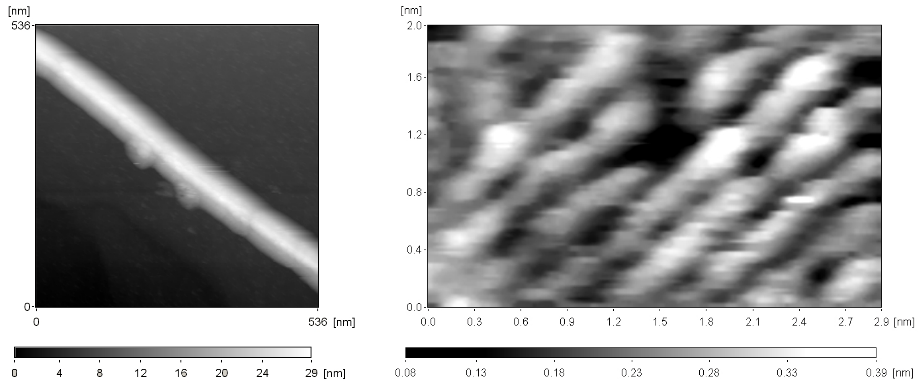
Recently, one dimensional structures built from SiC (nanocables, nanorods, nanowires and nanotubes) have been synthesized [5–8]. Currently, there are many reports in literature concerning growth of SiC nanowires (SiCNWs) based on mesoporous silica rich in Fe nanoparticles [9], chemical vapour deposition [10], SiO_x thin films [11], wood-based carbons [12], laser ablation [13] and the combustion synthesis [14–16].

2. Experimental

A few milligrams of the SiCNWs synthesized from $CaSi_2$ (42.2 wt.%) and PTFE (57.8 wt.%) [14–16] were sonicated for 30 min in 2 cm^3 of dichloroethane. The gold/mica and HOPG substrates were used. A droplet of the solution was then deposited on the prepared substrate. The sample was dried in the air for 1 h. Room-temp. STM and STS investigations were carried out in UHV (Omicron). The tips were prepared by mechanical cutting Pt90%–Ir10% alloy wires (Goodfellow). The XPS/ARXPS measurements were carried out using EA 125 HR (Omicron) hemispherical analyser.

3. Results

SiCNWs obtained in combustion synthesis are generally straight in shape but possess nanometer-scale defects (Fig. 1a) that have been shown by AFM and STM and ascribed to the local transformation of the 3C–SiC polytype into hexagonal one. High-resolution STM measurements showed local existence of flat regions on the sidewalls that was attributed to the formation of {100} facets (Fig. 1b).

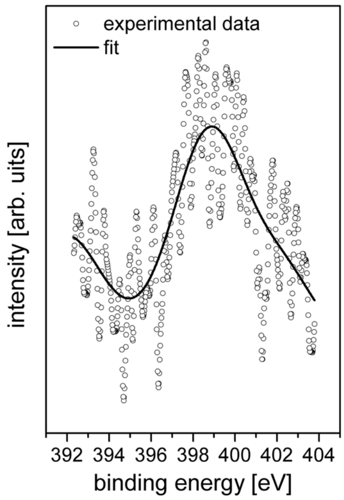


(a) (b)

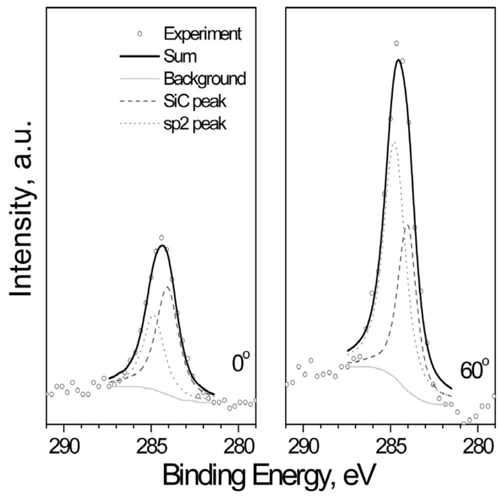
Fig. 1: (a) STM image of SiCNW with defects; (b) high-resolution STM image recorded on the sidewall of the SiCNW.

From STS measurements [17] it was found that the SiCNWs' surface LDOS is non-zero at the Fermi level and exhibits behaviour close to metallic. Good conductivity of SiCNWs and asymmetric LDOS character were attributed to the presence of noticeable amount of nitrogen (XPS, Fig. 2a) that acts as a donor but we have also taken into account the reconstruction-induced metallization to explain conducting properties of SiCNWs. Moreover, local presence of LDOS maxima below E_F was observed but their origin cannot be unambiguously determined in the present work.

Performed experiments proved that SiCNWs produced in combustion synthesis are conducting what makes them interesting because of the potential applications. We believe that SiCNWs are competitive with other nanostructures (e.g.



(a)



(b)

Fig. 2: (a) XPS signal for the N 1s; (b) the ARXPS results showing the evolution of C 1s peak.

carbon nanotubes) that can be used in construction of nanoelectronic devices or to improve mechanical and conductive properties of various composites.

Acknowledgements

This research was partly financed by European Regional Development Fund within the framework of Operational Programme Innovative Economy 2007–2013 (No. UDA-POIG.01.03.01-14-071/08-00) and by University of Łódź grant UŁ No. 505/694 (2009).

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