

INFRARED CHARACTERIZATION OF SILICON CARBIDE NANOWIRES

Ivan Karbovnyk^{1,*}, Pavlo Savchyn², Anatoli I. Popov^{3,4},
Andrzej Huczko⁵, Mariangela Cestelli Guidi⁶, Chiara Mirri⁶

1 Department of Electronics, Ivan Franko National University of Lviv, 107 Tarnavskogo str, 79017, Lviv, Ukraine

2 Department of Physics, Ivan Franko National University of Lviv, 8 Kyryla and Mefodiya str, 79005, Lviv, Ukraine

3 Institute of Solid State Physics, University of Latvia, Kengaraga 8, 1063 Riga, Latvia

4 Institut Laue-Langevin, 6 rue Jules Horowitz, 38042 Grenoble, France

5 Department of Chemistry, Warsaw University, 1 Pasteur str., 02-093 Warsaw, Poland

6 INFN-Laboratori Nazionali di Frascati, via E. Fermi 40, 00044 Frascati, Italy

ABSTRACT

Silicon carbide nanowires have been obtained via combustion synthesis route. X-ray diffraction analysis confirmed that the synthesized material is the 3C polytype of silicon carbide with zincblende unit cell. Detailed investigations of such SiC 1D nanostructures were carried out exploiting Fourier transform infrared spectroscopy. IR measurements were performed using BRUKER HYPERION FT-IR microscope. For the purpose of comparison, a series of powder samples were examined, including raw synthesis product, purified SiC nanowires and several commercially available micro- and nanopowders (from Alpha Aesar and PlasmaChem). Comprehensive comparative analysis of the MIR spectra has been performed.

Key words: silicon carbide, nanowires, infrared spectroscopy.

INTRODUCTION

Silicon carbide (SiC) is one of the important wide band gap semiconductors exhibiting high electron mobility, high Debye temperature and large breakdown voltage and thus having some technological advantages as compared to other materials of this class [1]. Several polytypes of SiC has been identified, including the most common ones: 3C, 4H and 6H. In the present report we focus on the 3C polytype (band gap 2.39 eV) [2] and will discuss the synthesis of novel 3C-SiC nanostructures and further infrared spectroscopy characterization of the obtained nanomaterials.

EXPERIMENTAL DETAILS

For the purpose of detailed FTIR studies we have prepared several powder samples. These include raw sponge-like combustion synthesis product contain-

* e-mail ivan_karbovnyck@yahoo.com, tel: (+38)0322394224

ing SiC nanomaterial and the product of the purification of the first sample. In order to compare the IR spectra of the obtained nanowires with those of other SiC nanostructures, SiC nanoparticles, bought from different companies, were also studied.

Typical SEM image of the investigated nanowires of silicon carbide is shown in *Fig. 1*.

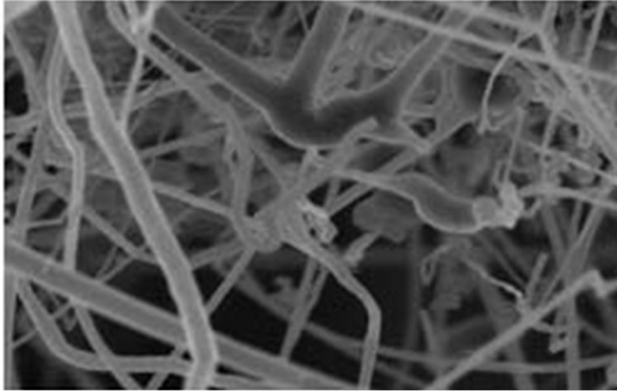


Fig. 1 – A typical SEM image of the synthesized SiC nanowires

For the purpose of IR characterization using BRUKER HYPERION FT-IR microscope investigated powders we mixed with KBr and pressed into pellets (the contamination of the SiC in the pellets was 0.1%). IR measurements were performed in the reflection mode with 2 cm^{-1} resolution in the wave-numbers range of 600 to 3000 cm^{-1} .

RESULTS AND DISCUSSION

MIR spectra of the synthesized 3C-SiC nanowires are presented in *Fig. 2*. Spectra of the selected commercial silicon carbide nanomaterials are shown on the same plot.

From *Fig. 2* it follows that commercial nanoparticles of silicon carbide exhibit typical feature peaked slightly above 800 cm^{-1} . It is obviously the manifestation of the fundamental Si and C sublattice corresponding to the reststrahl band of the SiC single crystal observed in the range of 770 to 1000 cm^{-1} .

In case of the synthesized nanowires one observes a different profile of the reflectivity peak which is strongly dependent on the purity of the material under study.

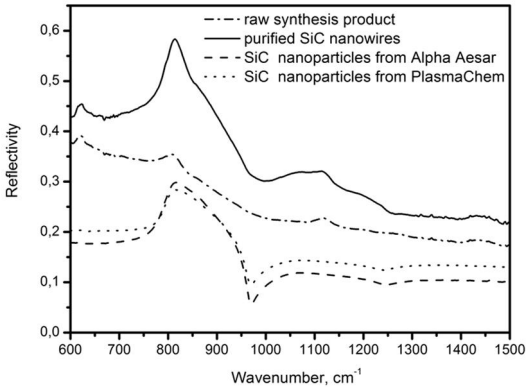


Fig. 2 – MIR spectra of the synthesized SiC nanowires and some commercial SiC nanopowders.

For the raw synthesis product the main peak is damped by strong background absorption. Generally, SiC nanowires show sharper reflectivity maximum than those of the nanoparticles. Both commercial samples have similar IR reflectivity spectra; slight difference might be due to different nanoparticle size distribution in these samples.

CONCLUSIONS

FTIR technique which is known to be highly sensitive to silica and a perfect method for the monitoring the surface structure and reaction analysis on sub-micrometer powders has been applied to study novel silicon carbide nanostructures.

Room temperature reflectivity spectra were recorded for unpurified and purified SiC nanowires and compared with the spectra of commercial SiC nanoparticles. The differences in the infrared spectra profiles of the nanowires and nanoparticles are emphasized.

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