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Electron beam processing of silicon carbide substrate to obtain graphene-like carbon films

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Nanostructured carbon films: graphene and graphene-like films are considered as future electronics materials for applications in nanoelectronics and carbon electronics [1]. Therefore, achieving their quality synthesis is in demand. Among the various methods of its obtaining the most interesting is the synthesis directly on silicon carbide substrates [2], e.g. thermal decomposition [3, 4]. Recently, various approaches using a irradiation technique or particle beam (laser, ion and electron beams) were extensively paid attention due to high precision, efficiency, mature control method, and fast speed [2, 5, 6]. The application of particle beam irradiation on graphene obtaining could present obvious advantages, including suitability for a large-scale production of graphene.

In this paper, we present our first result on graphene-like films fabrication by electron beam processing of silicon carbide substrate.

Several pieces of 35-42 mm^2 were cut from a 6H-SiC substrate and chemically cleaned. One sample was served as reference and other samples were then electron beam processed (EBP) for synthesis of graphene. EBP was carried out on a specialized electron beam system based on laboratory vacuum with the Pierce electron gun. An electron current of 50 to 180 mA and beam rate of a few mm/s were applied to heat the samples in pressure of 0.3-0.5 mTorr, so corresponding temperature were in the range of 1680 to 2000 K. The as-received layers as well as initial substrate surfaces on reference sample were characterized by Raman spectroscopy and atomic force microscopy.

A series of {0001} 6H-SiC samples were electron beam processed and nanostructured carbon films were available on the sample surfaces. Raman spectra of some samples are shown in Figure 1.

The D, G and 2D peaks as well as D/G (0.17-0.88) and 2D/G (0.70-0.89) ratios are detected. The FWHM of 2D peaks are 61-81. Temperature effects are discussed.

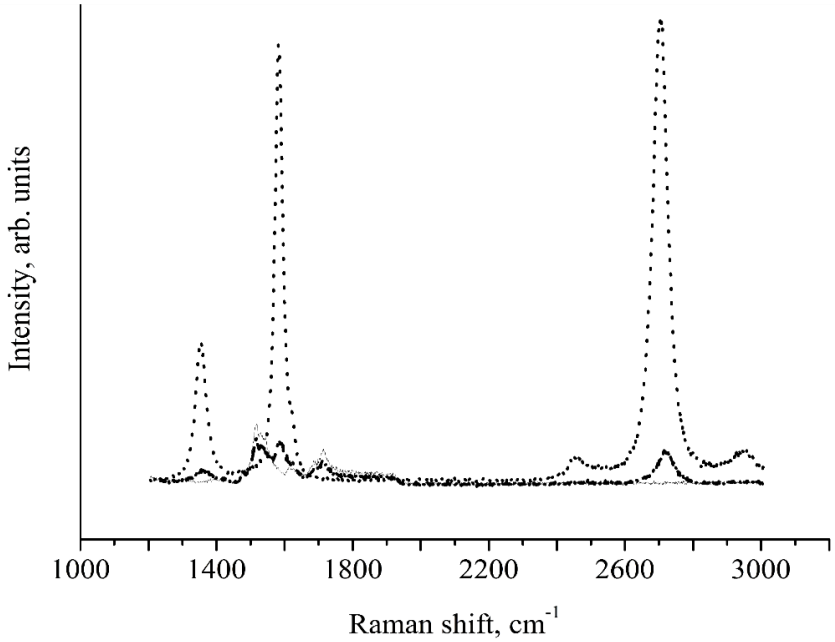

Figure 1. Raman spectra of reference (solid gray line) and electron beam processed (dashed and pointed black lines) 6H-SiC samples.

Comparison of the obtained results with known Raman spectra's and atomic force microscopy data [1-5, 7-9] allows us to assume that nanostructured carbon films, from monolayer to multilayer graphene and turbostratic graphite with various degrees of defects, are formed under the conditions of electron-beam processing.

It is expected that further optimization of the processing conditions will allow to fabricate required nanostructured carbon films.

Different nanostructured carbon films have been synthesized on {0001} 6H-SiC by electron beam processing. The preparation of graphene on silicon carbide substrates by EBP will be promising method in carbon electronic applications.

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