New electrochemical method of graphene and boron doped graphene synthesis in molten salts

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New electrochemical method of obtaining single-layer graphene or boron doped graphene (BDG) at the galvanostatic anodic polarization of some metals such as (titanium, zirconium) in molten alkali metal chlorides, containing up to 1.0 wt.% of some carbide powder (SiC, TiC, WC, B_4C) at a temperature of 843-973 K in an argon atmosphere was proposed. The thickness, area and number of layers of graphene can be controlled by boron carbide concentration, the process temperature and the anode current density: thus, for small polarizations and the electroless 2-4 h exposure in the melt film is formed of multilayer graphene film, while the anodic polarization - single-layer graphene, of significant area.

At the galvanostatic anodic polarization of platinum in molten alkali metal chlorides with boron carbide addition perfect films of boron doped graphene were synthesized. Boron concentration in the films varied from 0.2 to 58 wt.%. Significant changes were observed at Raman spectra of BDG as to Raman spectra of graphene. Additional peaks which belong to boron appeared at Raman spectra accompanied with traditional graphene ones. The height of boron peaks were as large as large was boron content in the BDG film.

The process has low temperature of graphene and BDG synthesis, it is perfectly reproduced, and the quality of graphene and BDG formed does not change from a series of experiments. The proposed method of electrochemical synthesis is cheaper and easier to known methods of synthesis of graphene and boron doped graphene and can be easily realized in practice to receive large-area high-quality single-layer graphene or boron doped graphene.

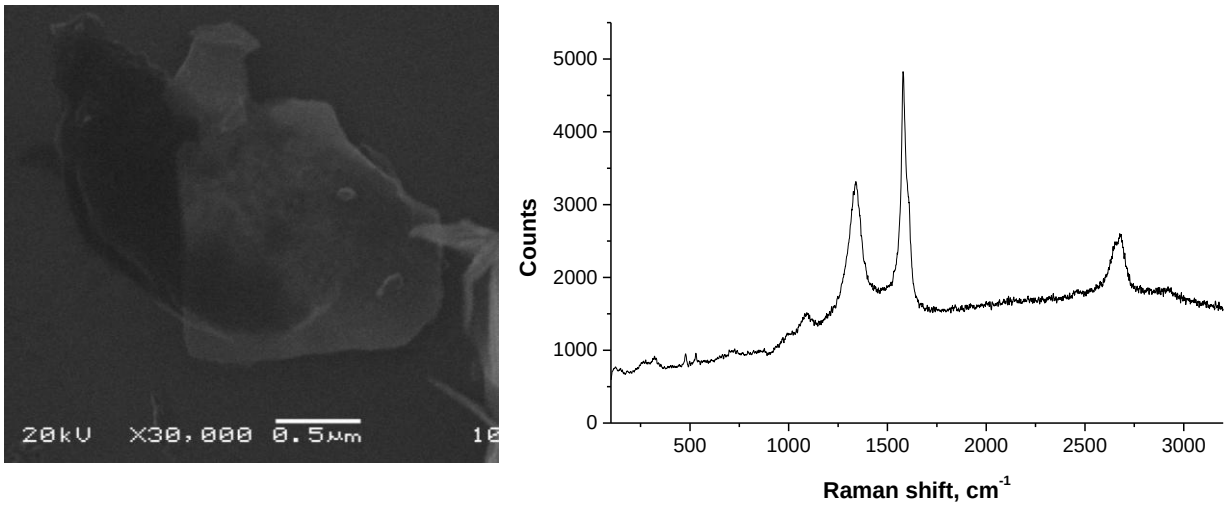

Fig. SEM image and Raman spectrum of graphene film doped with 0.7 at.% boron obtained after anodic polarization of platinum electrode in chloride melt with 0.2 wt.% B_4C at 843 K, current density 1.2 mA cm^{-2},