Doping of graphene with N^+ and B^+ ions by low-energy ion irradiation.

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Abstract:

Unique electrical properties make graphene a promising candidate for future electronic devices. Of paramount importance for the function of high-performance devices is the possibility of doping adjacent regions with different dopandants. An important milestone, especially for the industrial production of those devices is the realisation of a method for large-scale doping of graphene. A potential method for controlled doping of graphene, while minimizing the damage inflicted upon the sample, is low-energy ion irradiation [2-4].

In this work, we analysed the potential of graphene doping by the irradiation of N^+ and B^+ ions on epitaxial graphene on SiC at 25 eV. In a first step, we made simulations using the SDTrimSP Monte Carlo program for the irradiation of N^+ and B^+ ions at 25 eV on amorphous carbon (2 to 3 monolayer) on SiC. The results of the simulations show that most of the incident ions will stay in the first layer while nearly no sputtering, and hence no damage to the first layer, takes place. For experimental verification of the simulated findings, we used samples of epitaxial graphene grown on SiC, irradiated the samples with N^+ and B^+ ions at 25 eV and analysed them with scanning tunneling microscopy. The results clearly show that the implantation of both, N^+ and B^+ ions in graphene, was successful.

This work experimentally confirms that the irradiation of graphene by low-energy ions is a promising technique for controlled doping of graphene with N^+ and B^+ Ions. Two great advantages of this method are the minimization of damage of the graphene layer and its potential to use it on large-scale for industrial production.

References:

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Figures:

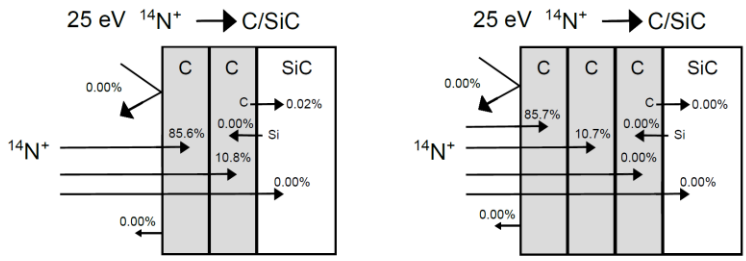

Fig.1: SDTrimSP simulation for N^+ ion irradiation on 2-3 monolayer of amorphous carbon on SiC at 25 eV. The N^+ concentration differs from 100% due to rounding differences.

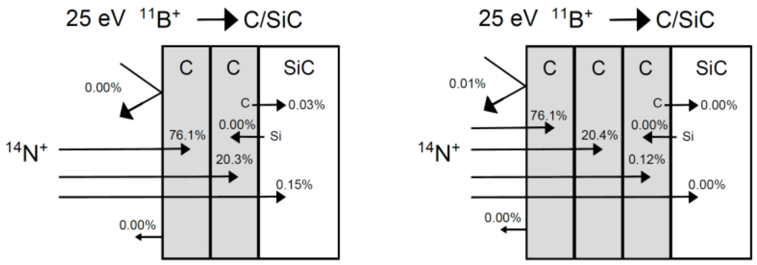

Fig.2: SDTrimSP simulation for B^+ ion irradiation on 2-3 monolayer of amorphous carbon on SiC at 25 eV. The N^+ concentration differs from 100% as a result of rounding differences.

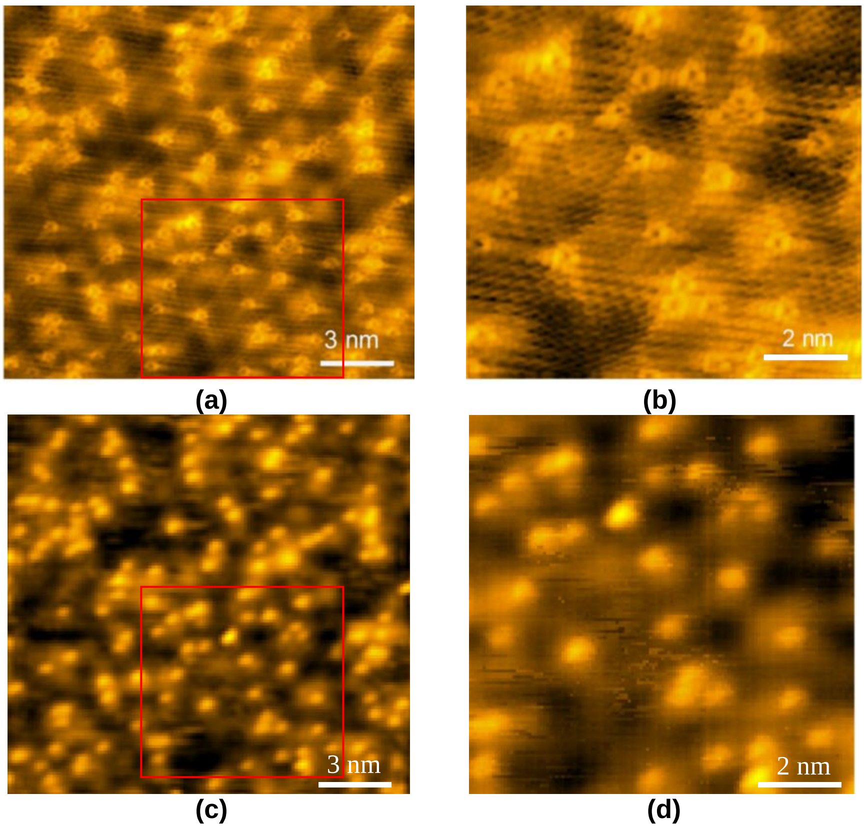

Fig.3: STM topography of epitaxial graphene grown on SiC doped with N^+ ions. The pictures (a) and (c) show the same area at different voltages. The pictures (b) and (d) show a detail of the pictures (a) and (c), respectively.

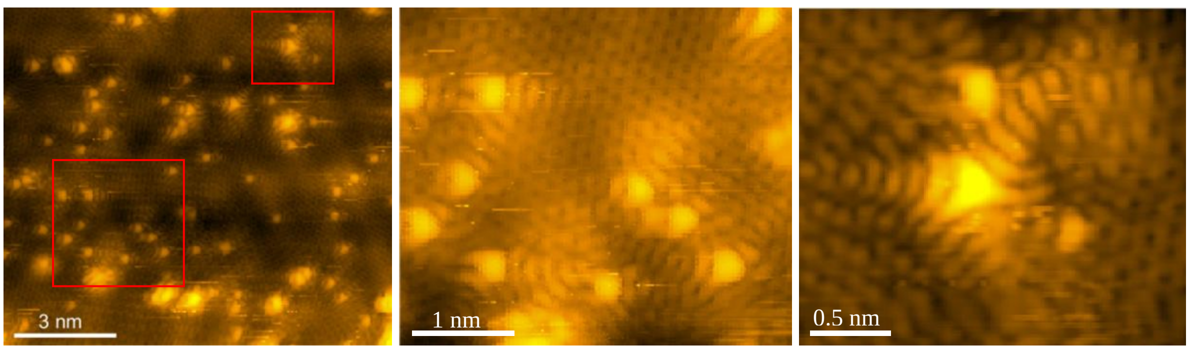

Fig.4: STM topography of epitaxial graphene grown on SiC doped with B^+ ions. The pictures show different resolutions of the same sample.