A NOVEL METHOD FOR FAST GROWTH OF EPITAXIAL GRAPHENE ON SiC(0001) USING AN INFRARED LASER

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Abstract

Perhaps, the most promising method for large area, high quality graphene production is the thermal decomposition of SiC, due to Si sublimation, which leads to the growth of epitaxial graphene (EG). Apart from the fact that EG is patternable the main advantage of this method is that graphene grows directly on a material useful in the electronics platform. EG grown on SiC is usually several layers thick. However, the electronic properties of the multilayer EG are comparable to those of single layer graphene and this makes the field rather exciting. The predominant approach used to obtain EG on SiC is thermal annealing (at T>450 K using induction heating) of SiC wafers either in vacuum or under controlled Ar atmosphere. In the current work, a novel facile method for the single-step, fast production of large area, homogeneous EG on the SiC(0001) using a continuous wave infrared CO2 laser (10.6 m) as a heating source. The process does not require high vacuum or strict sample-chamber conditions; it takes place under Ar gas flow at atmospheric pressure and temperature. The formation of few layer EG on SiC and its features were investigated by scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), secondary ion-mass spectroscopy (SIMS), and Raman scattering. SEM images revealed that the whole area illuminated by the CO2 laser is homogenous. The thickness of the film (~2.5±0.5 nm or 5.5–8.5 monolayers) was evaluated by XPS and dynamic SIMS (depth profile) measurements. The overall area where the EG growth took place (~4 mm²) was monitored by micro-Raman spectroscopy using the 441.6 nm and 514.5 nm laser lines. Analysis of the Raman spectra: (i) show very low fraction of defects; (ii) suggest the existence of disorder or stacking faults between graphene layers, which is essential for enhanced electronic properties of multilayer graphene; (iii) demonstrate homogeneous strain distribution over macroscopic areas with very low strain magnitude. Given these promising findings, scalability to industrial level of the method described here appears to be realistic, in view of the high rate of CO2-laser induced graphene growth and the lack of strict sample–environment conditions.

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