Improved crystallographic high quality of thermally decomposed epitaxial graphene on 6H-SiC

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Research on the creation of graphene-channel terahertz (THz) light-emitting and laser transistors are now emerging[1]. To realize it one needs a highest quality of graphene having sufficiently long carrier momentum relaxation times at least on the order of ps for obtaining reasonably high net gain in the THz range [2]. We report on improved crystallographic high quality epitaxial graphene on a SiC substrate synthesized by the thermal decomposition method[2]. The synthesis process starts by degassing the furnace in UHV at 800 °C for 30 min. A C-face 6H-SiC substrate is introduced to the furnace to be annealed in an atmospheric pressure Ar-gas flow at a high temperature, desorbing Si atoms from the surface of the SiC substrate. Annealing temperature T_{anl} directly affects the Si desorption rate and self-organized formation of graphene by the remained C atoms [3]. Ar gas flow rate R_{Ar} also sensitively affects the Si desorption rate and resultant surface morphology. Promotions of uniform desorption of Si atoms and well-regulated C networking are the keys to synthesize highest quality of graphene. We studied the thermo-chemical dynamics on epitaxial graphene synthesis controlled by the annealing temperature and the Ar gas flow. Compared to the original conditions (T_{anl}: 1390 °C, annealing time: 10 min., R_{Ar}: 0.1 slm (Sample A)), we increased both the parameters to the optimal levels (T_{anl}: 1420 °C, annealing time: 5 min., R_{Ar}: 0.5 slm (Sample B)) to increase the activation energy and to stimulate the Si atoms uniform evacuation. The crystallographic quality of graphene was characterized by the distributions of the FWHM of the G' peak in Raman spectra. Sample B has low FWHM values of the G' peak in broader areas than Sample A, but a few areas of Sample B have rather high FWHM values (Fig. 1). The surface morphology of the samples measured by AFM clearly correlates with the Raman spectral profiles. The areal density of the ripples, which may affect the carrier transport properties of graphene [4], was significantly reduced in Sample B, enlarging the single-domain area by order of magnitude (Fig. 2). In conclusion, we experimentally confirmed the improvement of the crystallographic quality of epitaxial graphene on hexagonal SiC. This work is financially supported by JSPS KAKENHI #16H06361, Japan.

References

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Figures

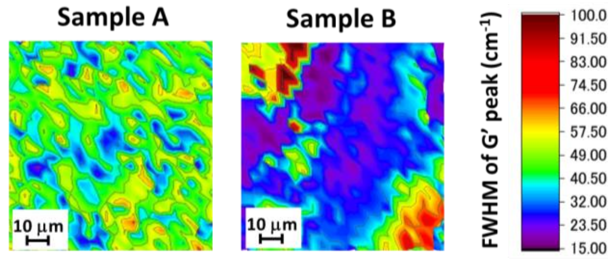

Figure 1: Distribution of FWHM of G' peak.

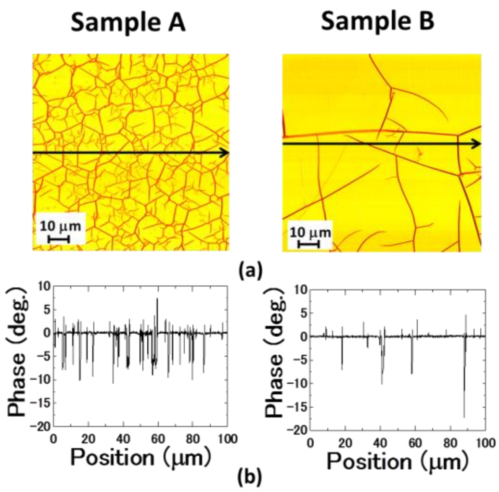

Figure 2: (a) 100 µm × 100 µm AFM image of graphene, (b) Line profile of the ripple height marked with an arrow in panel (a).