Repair for Process-induced Defects of Transferred Graphene

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Formation of few layer epitaxial graphene on SiC substrate by Si sublimation is one of the most important issues to obtain the high quality and large area graphene with controlled layer numbers.[1] From the various application viewpoints, we think that it is necessary for the epitaxial graphene with large area to transfer from the SiC original surface onto the arbitrary insulator layers such as SiO_2 layer formed on Si substrates. We have already reported that such transfer process of the large area epitaxial graphene from the Si-face SiC substrate onto the SiO_2 layer can be successfully established using the Ti intermediate layer deposited on the graphene and we have successfully achieved to obtain the large area (4mm × 7mm) mono- and bi-layer transferred graphene on the SiO_2/Si substrate.[2] However, there is one serious problem in this transfer process, that is, some defects are induced in the final stage of the transfer process. Therefore, the repair technique for the defects of the transferred graphene on the SiO_2/Si substrate should be necessary to obtain the high quality transferred graphene on the SiO_2 layer. In this work, we have investigated that a new repair technique for the defects by carbon MBE are very effective to improvement the quality for the process-induced defects of the large area transferred epitaxial graphene.

We have investigated about the thermal stability of the defective transferred graphene at 800℃, 900℃, and 1000℃ under the ultra high vacuum (UHV) better than 1.0×10^{-9} Torr, before the investigation of the repair technique of the defects. The carbon MBE onto the defective transferred graphene surface was performed at 900℃ under the ultra high vacuum better than 1.0×10^{-9} Torr to explore a possibility of the repair of process-induced defects. We used carbon heater as a carbon beam source for MBE to supply carbon atoms onto the transferred graphene surface. The quality of the transferred graphene before and after the repair by the carbon MBE was characterized by the microscopic laser Raman spectroscopy.

Figure 1 shows Raman spectra from the two points of A and B with the different quality on the transferred graphene before and after the UHV annealing. All Raman peaks from both points of A and B shifted to the high energy side by annealing. The increase of Raman intensity between the D and the G peaks indicates that the defective transferred graphene net easily changed to the amorphous carbon by the UHV annealing. Figure 2 shows the typical Raman spectra from the transferred graphene before and after the repair process by the carbon MBE. We can easily observe the drastically decrease of the defect originated D- and the D'-band peak intensities after the carbon MBE and the result strongly indicate that the repair of the defects by the carbon MBE is expected to improve the quality of the transferred graphene.

References

[1] K. Hayashi, S. Mizuno, S. Tanaka, H. Toyoda, H. Tochihara and I. Suemune, Jpn. J. Appl. Phys. Express Lett, **44** (2005) L803.
[2] A. Hashimoto, H. Terasaki, K. Morita, H. Hibino and S. Tanaka, International Conference On Silicon Carbide And Related Materials, (2009) Tu-P-86.

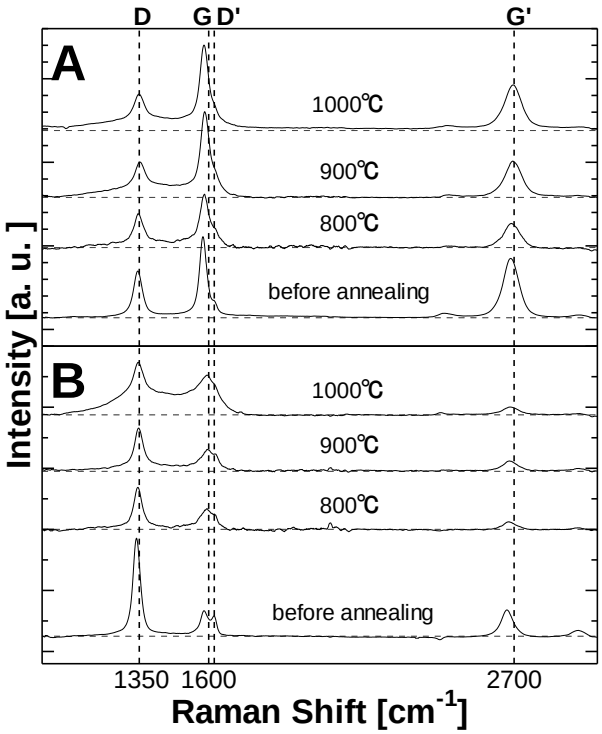

Fig. 1 Raman spectra from transferred graphene by UHV annealing

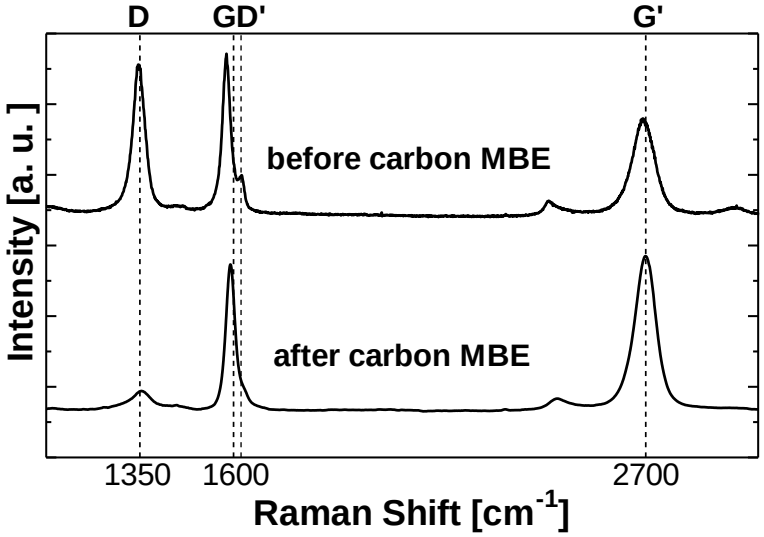

Fig. 2 typical Raman spectra from transferred graphene before and after repair process by carbon MBE