Strain introduction into graphene via Pd intercalation

Ayato Yamane[1], Tomo-o Terasawa[2], Takahiro Ito[3], and Wataru Norimatsu[1]

[1] Faculty of Science and Engineering, Waseda University, 3-4-1, Okubo, Shinjuku-ku, Tokyo 169-8555, Japan

[2] Advanced Science Research Center, Japan Atomic Energy Agency, 2-4 Shirakata, Tokai, Ibaraki 319-1195, Japan

[3] Nagoya University Synchrotron Radiation Research Center (NUSR), Nagoya University, Furo-cho, Chikusa, Nagoya 464-8603, Japan

e-mail: ayt1129@akane.waseda.jp

Graphene, a one-atom-thin carbon material, can be grown by thermal decomposition of SiC. When the SiC single-crystal substrate is heated, the buffer layer is formed prior to graphene growth. Carbon atoms in this buffer layer have covalent bonds with the silicon atoms in SiC. Foreign elements can be intercalated into the interface between the buffer layer and SiC, which transforms the buffer layer into quasi-free-standing monolayer graphene. In this study, we attempted Pd intercalation. Pd intercalation is expected to induce strain in graphene due to its strong interaction with carbon. In this study, we investigated the spatially distributed strain in graphene by Pd intercalation.

The buffer layer samples were prepared by heating the SiC single-crystal substrate at 1580°C for 3 min. Pd was deposited by a molecular beam epitaxy technique at room temperature on a buffer layer, and then the substrate was heated to 400-900°C for intercalation. The samples were characterized by atomic force microscopy (AFM), Raman spectroscopy, and angle-resolved photoemission spectroscopy (ARPES).

From the Raman spectra before and after the intercalation treatment, we found that the buffer layer was converted into graphene by Pd intercalation. Figure 1 shows the Raman spectra of a sample in which Pd intercalation was attempted by annealing at 900 °C after depositing Pd with the thickness of 1 nm. Peak positions of the G and 2D band in the spectra exhibited a significant redshift as shown by a red line. Figure 2 shows the relation between the G and 2D band peak positions and strain, indicating that the Pd-intercalated graphene was subjected to tensile strain of approximately 0.8–1.2%. In the AFM and Raman mapping images, intercalated and non-intercalated regions were alternately arranged in a striped pattern.

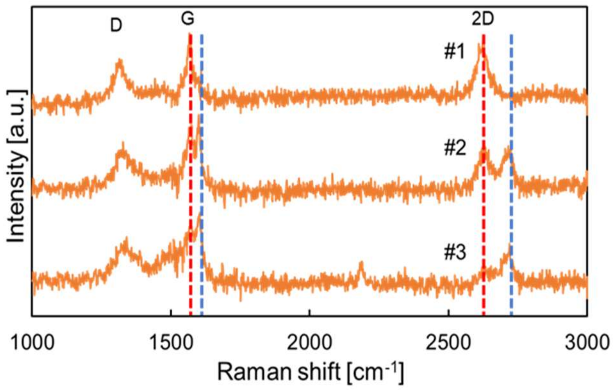

Fig. 1 Raman spectra of a sample after Pd-treatment measured at three different points (#1-#3).

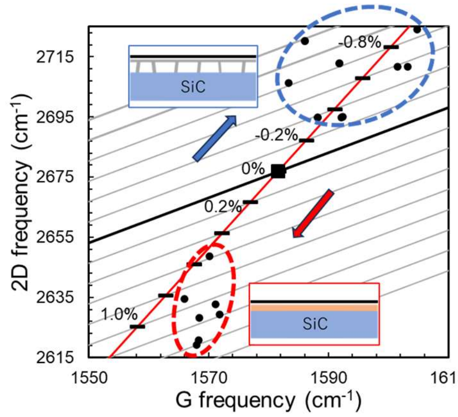

Fig. 2 Relation between G and 2D band peaks and strain of Pd-intercalated (red) and epitaxial graphene on SiC (blue).