Raman spectroscopy of Ar^+ irradiated graphite surfaces supporting platinum nanoparticles

Objective

To investigate the influence of the ion-beam irradiation (with Ar) and the Pt nanoparticles deposition on the surface structure of carbon supports (HOPG) by Raman spectroscopy.

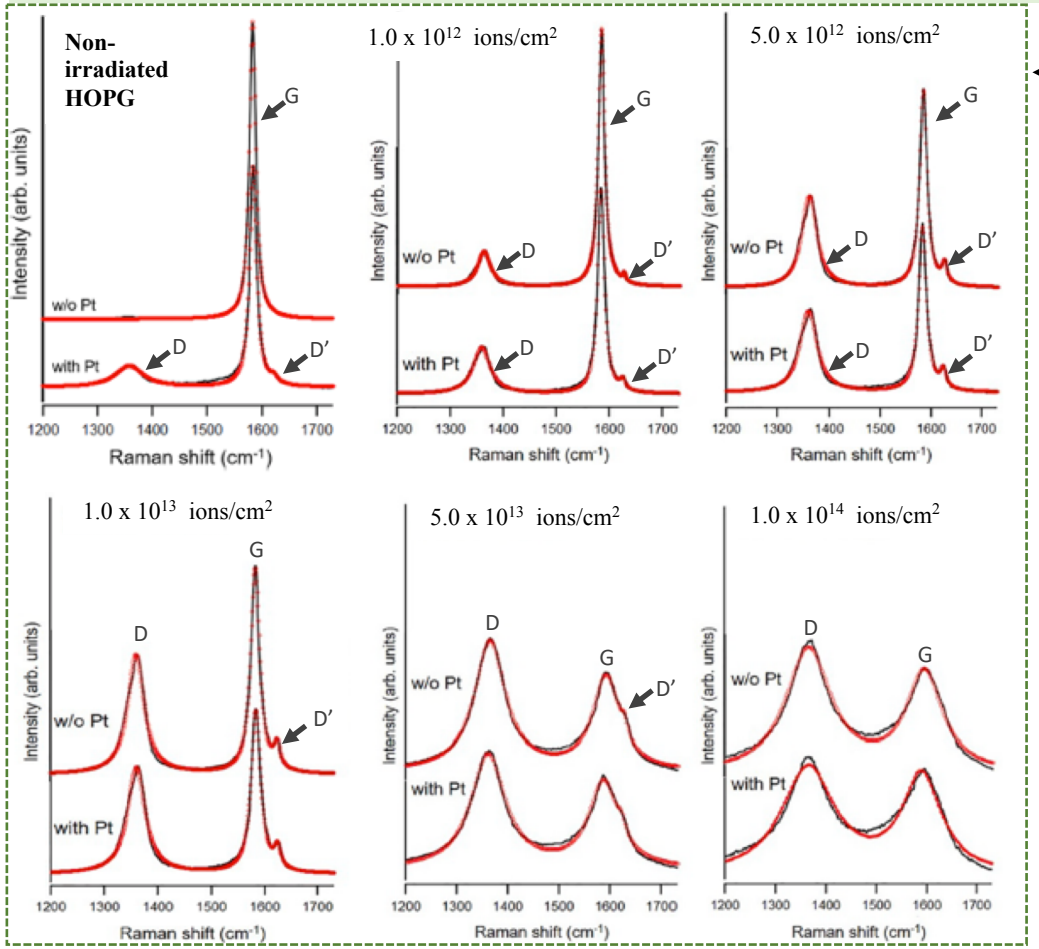
Sample Preparation

Firstly, thin specimens of HOPG were obtained from this bulk material using adhesive tape. Then, the specimens were irradiated with Ar at an energy of 380 keV and fluences between 1.0×10^{12} and 1.0×10^{14} ions/cm^2, using an ion implanter. Subsequently, Pt nanoparticles were deposited on the irradiated HPOG surfaces through an RF magnetron sputtering method (20 W, 13.56 MHz, and 60 s). Also, Pt nanoparticles were deposited on some pristine HOPG samples (non-irradiated).

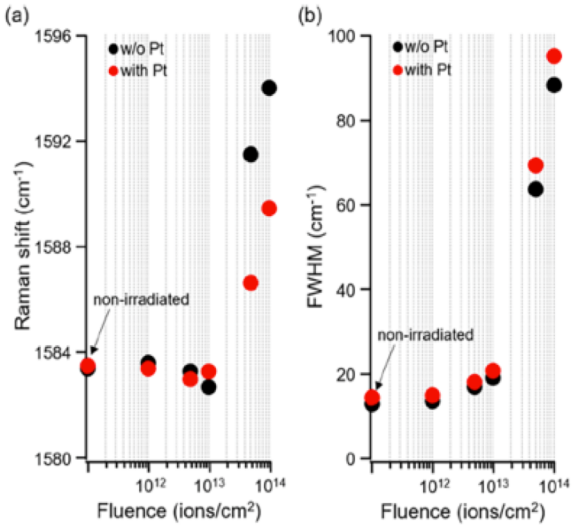
Data acquisition

Raman spectra of the irradiated and non-irradiated HOPG surfaces before and after the Pt deposition was performed using a LabRAM HR Evolution Raman spectrometer (HORIBA, Ltd., Japan) over the wavenumber range of 500–2000 cm^{-1} at a resolution of 1.60 cm^{-1}. Incident radiation at 532 nm was provided using a single mode green laser at a power level below 5 mW, applied to a sample area with a diameter of approximately 15 µm.

Representative figures & Results



The Raman spectra of the non-irradiated HOPG without (w/o) and with Pt deposition and of the HOPG irradiated with Ar^+ at a fluence between 1.0×10^{12} and 1.0×10^{14} ions/cm^2 without (w/o) and with Pt deposition. Red circles and black curves represent experimental data and Lorentz curve fitting, respectively.



The (a) position and (b) FWHM of the G peak plotted against Ar fluence (black point: without Pt, red point: with Pt).

Conclusion

The effect of Pt deposition induced damage on the HOPG surfaces by itself, this was concluded by the appearance of D and D' peaks in the Raman spectrum of the non-irradiated HOPG + Pt nanoparticles, and also observed slightly in the irradiated HOPG. Ion irradiation also causes defects on the HOPG surfaces. On the fluence of over 5.0×10^{13} ions/cm^2 was observed blueshift of the G peak by the Ar irradiation and redshift of the G peak by the Pt deposition. The redshift after Pt deposition becomes more obvious with the higher degree of HOPG modification (higher Ar fluence). By means of calculations was determined that approximately three-point defects were present at the interface between each 5 nm Pt nanoparticle and the Ar irradiated HOPG.