Substrate Dependent Raman D Band of Mechanically Exfoliated Graphene

Nobuhiko Mitoma, Ryo Nouchi, Xiao-Yan Fan, Katsumi Tanigaki

Tohoku University, 6-3 Aoba, Aramaki, Aoba-ku, Sendai, Japan
mitoma@sspns.phys.tohoku.ac.jp

Graphene is a rising star in recent condensed matter physics. It has been attracting lots of interests not only from the viewpoint of fundamental physics but also as an exciting potential candidate for future electronic devices. Here, we investigate the effect of substrates on the Raman D band of mechanically exfoliated graphene.

It is important to use graphene with high quality when we investigate its fundamental properties. There are several methods to obtain graphene such as chemical vapor deposition. We employ mechanically exfoliation in this study. This method is not suitable to application; however, graphene obtained from this method has less defects compared with graphene obtained from other methods.

We can get lots of information about graphene by using the Raman spectroscopy. Characteristic Raman spectra of graphene are named D(~1350 cm^{-1}), G(~1570 cm^{-1}), 2D(~2680 cm^{-1}) bands. Among them the D band peak is thought to originate from defects in graphene. A recent paper[1] says that mechanically exfoliated graphene also shows very weak Raman D band and it originates from strongly-adsorbed atoms/molecules on the graphene surface.

We deposited graphene on various kinds of substrates and took Raman spectroscopy. Two of them are shown in Fig. 1. The blue curve is the data obtained from graphene on a pristine SiO_2 substrate, and the red one is from graphene on an O_2 plasma treated SiO_2 substrate. These curves are normalized with respect to the G band intensity and shifted for clarity. We can see peak shifts of the G and 2D bands. These are considered due to carrier doping effect as the O_2 plasma treated surface becomes hydrophilic and adsorbed H_2O molecules induce the doping effect. Magnified spectra around the D band is shown in Fig. 2. Weak but non-negligible D band has appeared with the sample on the pristine SiO_2 substrate. On the other hand, the peak was suppressed with the sample on the plasma treated substrate. If the adsorbates on the graphene surface induce the D band, both samples should display the D band. If the hydroxyl groups on the SiO_2 substrate enhance the D band, a larger peak should be observed in graphene on the O_2 plasma treated substrate. We propose an idea that the substrate surface roughness enhances the D band. We will discuss the origin of the substrate-dependent D band from the viewpoint of the curvature-induced D band[2].

References

[1] Z. H. Ni *et al*., Nano Lett., **10** (2010) 3868.
[2] A. K. Gupta *et al*., J. Phys.: Condens. Matter., **22** (2010) 334205.

Figures

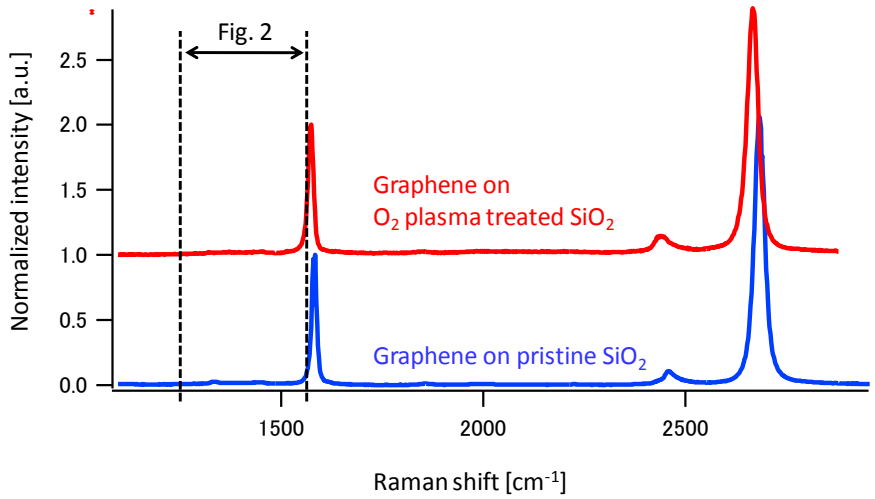

Fig. 1. Raman spectra of graphene on two kinds of substrates. The curves are normalized with respect to the G band intensity and shifted for clarity.

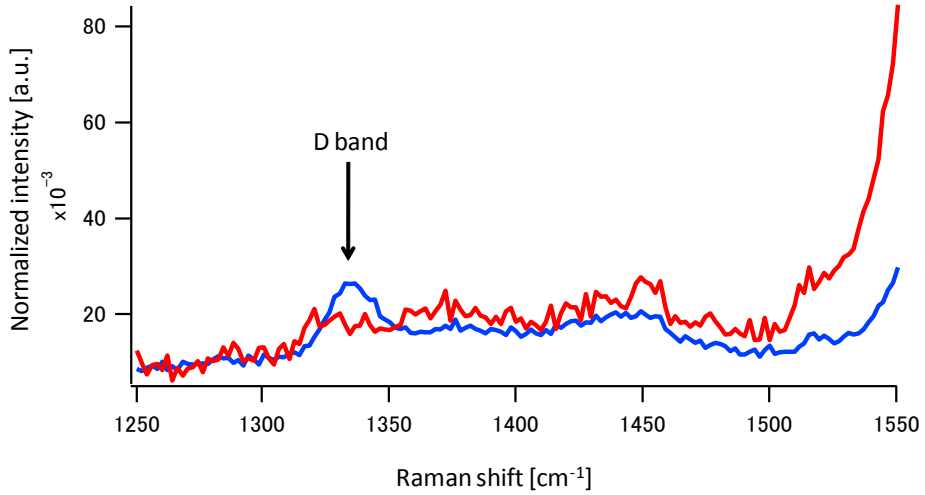

Fig. 2. Magnified Raman spectra around the graphene D band. The band is suppressed when graphene is on the O_2 plasma treated substrate.