Raman Characteristics of Graphene with Inhomogeneous Isotope Distribution

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In the natural carbon materials, such as exfoliated graphene, stable ^{13}C (abundance ~1.1%) uniformly coexists with ^{12}C (~98.9%). Taking advantage of "bottom-up" method, one can expect to directly fabricate graphene crystals with different carbon isotope concentrations, which can be further proved by Raman spectroscopy, due to the mass difference between ^{12}C and ^{13}C. If two graphene regions with different ^{13}C concentrations are continuously synthesized, how to determine the isotope distribution in the joint area is an interesting topic.

Here, we investigate the Raman characteristics of graphene crystal containing connected regions with various isotope concentrations. The large scale isotope-enriched graphene was synthesized by chemical vapor deposition (CVD) method using a mixture of $^{12}CH_4$ and $^{13}CH_4$ with different proportioning. In the uniform isotope doped regions, Raman features, including position and width of G and 2D band, are dependent on the isotope concentration (Fig. 1(a-b)), which is consistent with previous results. [1-2] However, at the joint area between two homogeneously doped regions, Raman G-band-width map shows a significant bright feature, indicating that the lifetimes of Raman active phonons shorten at where spatial inhomogeneity of isotope doping exists. This inhomogeneous isotope distribution in graphene may be useful in modifying the thermal conductivity of carbon based materials. [3]

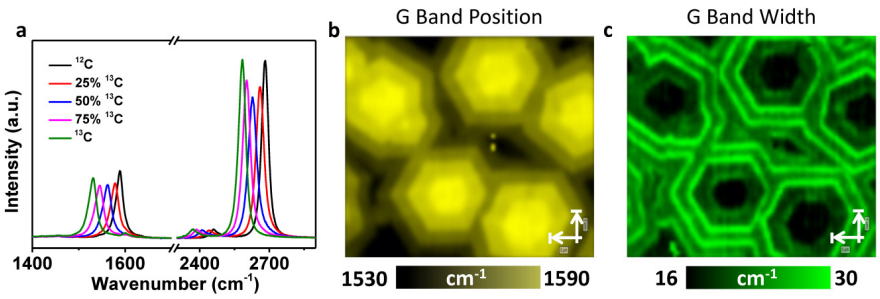

Fig. 1. Raman spectrum and maps of isotope-doped CVD graphene. (a) Raman spectrum of CVD graphene grown with different concentration of $^{13}CH_4$. (b-c) Raman G band maps of CVD graphene. The scale bar is 5 μm.

References

[1] J. F. Rodriguez-Nieva et al. Phys. Rev. B, 2012, 85, 245406.

[2] B. R. Carvalho et al. Phys. Rev. B, 2015, 92, 125406.

[3] S. Chen et al. Nat. Mater., 2012, 11, 203.