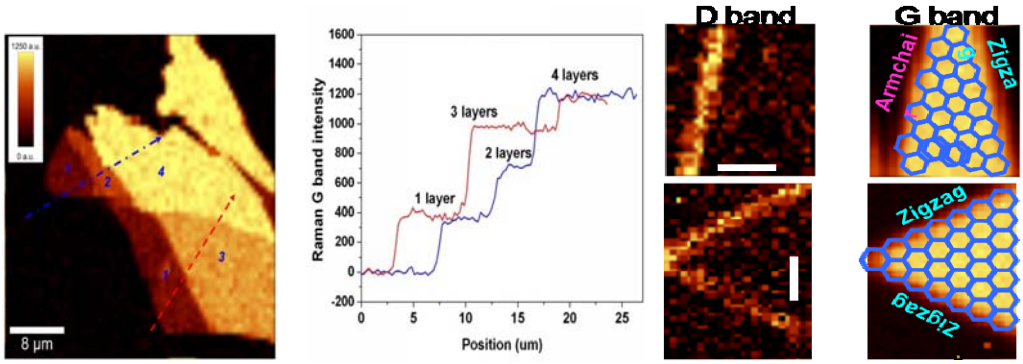
Raman imaging of graphene: from fundamental study to applications

Z. X. Shen (zexiang@ntu.edu.sg), Z. H. Ni, Y. Y. Wang, YM You, D. Zhan, ZQ Luo, L Liu and T. Yu
Division of Physics and Applied Physics, School of Physical and Mathematical Sciences, Nanyang Technological University, Singapore 637371, Singapore

Graphene exhibits many exciting properties, such as anomalously quantized Hall effects, massless Dirac-Fermions like charge carrier, existence of a minimum conductivity, which make it promising material for the future nano-electronic devices. All these properties are originated from its unique band structure whose conical valence and conduction bands meet at the Dirac point in Brillouin zone.

Raman spectroscopy/imaging has been historically used to probe structural and electronic characteristics of carbon materials. In this talk, we use Raman imaging to study graphene in the following aspects. (1) Raman imaging in together with contrast imaging can be used to unambiguously determine the graphene thickness. (2) determination of graphene axes using Polarized Raman spectroscopy (3) Raman imaging of folded graphene sheets has revealed the two dimensional Dirac-like (single layer graphene-like) character of electronic states and with reduction of Fermi velocity. (4) We have also studied the effect of top insulator layer deposition (SiO_2, HfO_2, PMMA) with different techniques (ALD, PLD, Sputtering, spin coating) on the properties of graphene. The effect of high temperature annealing and molecular doping is also studied. (5) Uniaxial strain is applied on graphene, and the strain is detected by Raman spectroscopy and imaging. Bandgap opening on graphene, which is critical to its application, is possible by applying such strain. The results obtained here by Raman imaging help on the better understood of fundamental properties of graphene and might speed up its application on future electronic devices.



1. Ni ZH, Wang YY, Yu T, **Shen ZX** Raman spectroscopy and imaging of graphene *Nano Research* (Invited Review) 1, 273, (2008).
2. YM You, ZH Ni, T, Yu, **ZX Shen**, From cleavage to chirality identification: edge etermination of graphene by Raman spectroscopy, *Appl Phys Lett*, 93, 163112 (2008).
3. Ni ZH, Wang YY, Yu T, You YM, and **Shen ZX**, Reduction of Fermi velocity of folded graphene observed by resonance Raman spectroscopy, *Physical Review B*, 77, 235403 (2008).
4. Ni ZH, Wang HM, Kasim J, Fan HM, Yu T, Wu YH, Feng YP, **Shen ZX** Graphene thickness determination using reflection and contrast spectroscopy *Nano Letters* 7 (2007): 2758-2763.