Graphene as Structural Template to Control Interfacial Molecular Orientation

Mao Hongying,[1] Wang Rui,[2] Wang Yu,[1] Niu Tianchao,[2] Zhong Jianqiang,[1] Huan Mingyang,[1] Qi Dongchen,[2] Kian Ping Loh,[1] Andrew Thye Shen Wee,[2] Chen Wei*[1,2]

E-mail: phycw@nus.edu.sg(Dr. Chen Wei)

Department of Chemistry, National University of Singapore, 3 Science Drive 3 Singapore 117543

Department of Physics, National University of Singapore, 2 Science Drive 3 Singapore 117542

Introduction

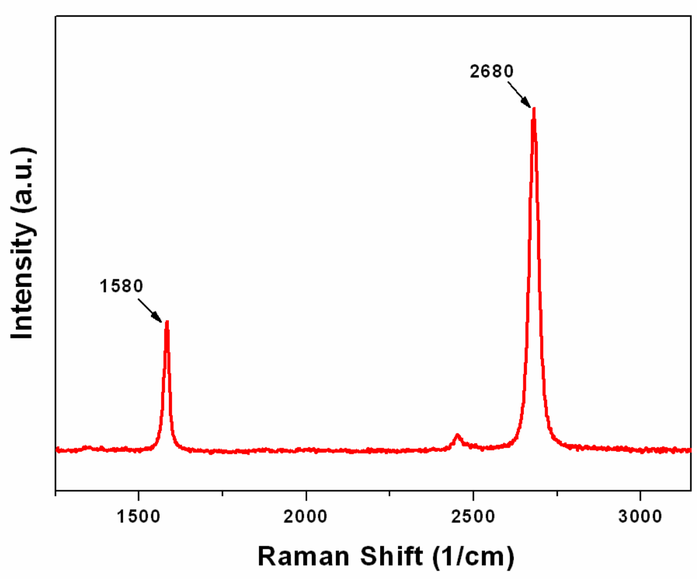
controlling the molecular orientation for efficient charge transport could be an effective method to increase device performance.[1] Here we demonstrate the successful use of CVD graphene film as structural template to control the molecular orientation of organic thin films of chloroaluminum phthalocyanine (ClAlPc) on ITO electrode, as revealed by *in-situ* near-edge X-ray absorption fine structure (NEXAFS) spectroscopy, ultraviolet photoelectron spectroscopy (UPS), and low-temperature scanning tunneling microscopy (LT-STM) experiments.

Experiment

- **NEXAFS experiments were performed at the *SINS* beamline of Singapore Synchrotron Light Source in an ultrahigh vacuum chamber with a base pressure of 1×10-10mbar. NEXAFS spectra of N K-edge were recorded in total electron yield (TEY) mode.**
- **UPS measurements were performed in a homemade ultrahigh vacuum system with a base pressure better than 2×10-10 mbar with He I (hν = 21.2 eV) as excitation source.**
- **All STM images were recorded in constant-current mode at 77 K in an Omicron low temperature scanning tunneling microscopy system with a base pressure better than 6×10-11mbar.**

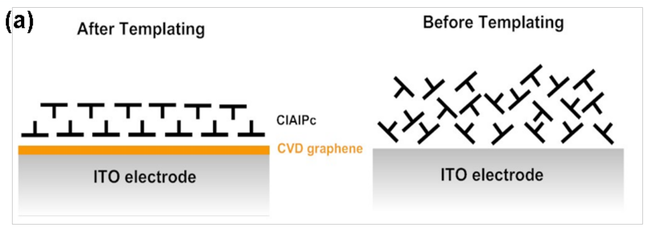
Results and Discussions

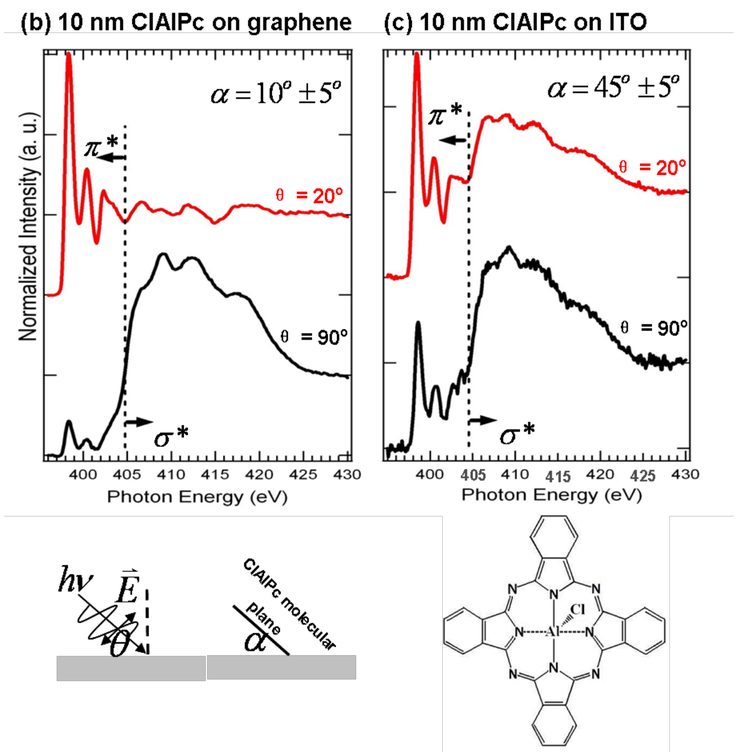
Raman Spectroscopy of CVD graphene



Mono layer Graphene

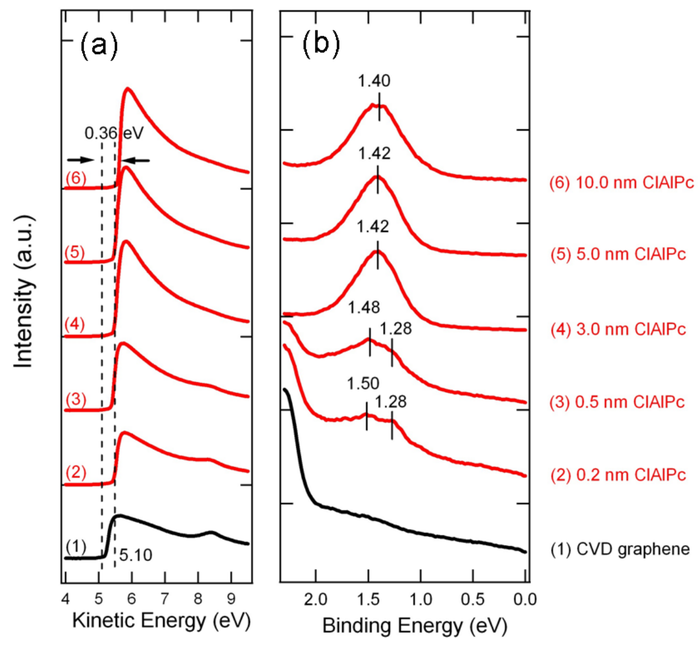
Orientation of ClAlPc on CVD graphene





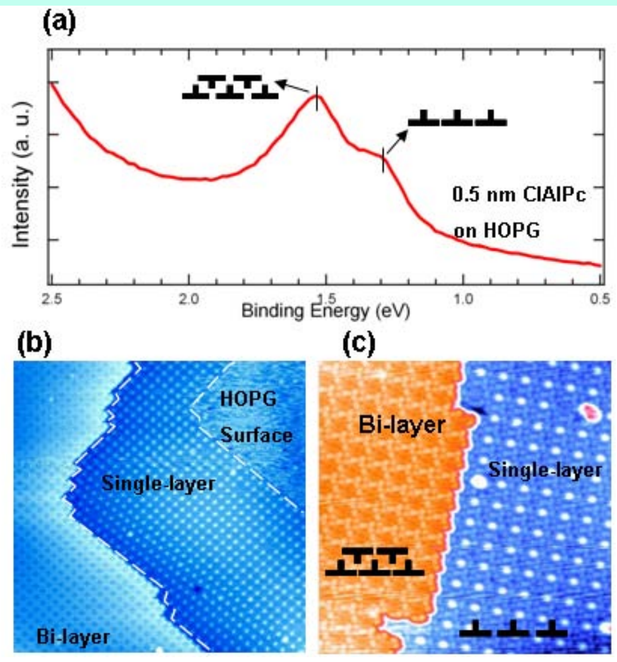
(a) Schematic of the proposed molecular packing structure for ClAlPc molecules before and after templated by CVD graphene. Angular-dependent N K-edge NEXAFS spectra for 10 nm ClAlPc film on (b) CVD graphene modified ITO and (c) bare ITO electrodes. The molecular structure of ClAlPc is shown at the bottom of the Figure.

Electronic structure of ClAlPc on CVD graphene



UPS spectra of ClAlPc on CVD graphene (a) at the low kinetic energy region and (b) at the low-binding energy part near the E_F region.

Orientation of ClAlPc on HOPG



(a) UPS spectrum near the E_F region for 0.5 nm ClAlPc on HOPG surface (b) STM image showing the coexistence of the single-layer, bi-layer ClAlPc film and bare HOPG surface (50×50 nm2, Vtip =2.7 V); (c) STM image showing the formation of the single-layer and bi-layer ClAlPc film (20×20 nm2, Vtip =2.6 V),

Conclusions

CVD graphene on ITO electrode has been used as a structural template to manipulate the molecular orientation of ClAlPc film with their π-plane stacking direction nearly perpendicular to the ITO surface, and hence to improve the efficiency of charge transport along this direction.

References:

1 Chen Wei, Qi Dongchen, Huang Han, Gao Xingyu, Andrew Thye Shen Wee, *Adv. Funct. Mater.* 2011, 21 410.