Construction of Novel 2D Atomic Crystals on Transition Metal Surfaces and Physical Properties: Graphene, Silicene, Germanene, Hafnene, $PtSe_2$ and $HfTe_n$

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Abstract

The novel properties of graphene-like honeycomb structure have spurred tremendous interest in investigating other two-dimensional (2D) layered structures beyond graphene. In this lecture, I will present construction of graphene, silicene, germanene, hafnium honeycomb lattice, monolayer $PtSe_2$ as well as $HfTe_3$/$HfTe_5$, a superconductor-topological insulator layered heterostructure, on transition metal surfaces (TMS) (for example, Ru(0001), Pt(111), Hf(0001) and Ir(111)). Molecular beam epitaxial growth technique is used to form the large scale 2D atomic crystals on TMS. Low electron energy diffraction (LEED) and scanning tunneling microscopy/spectroscopy (STM/S) together with density functional theory (DFT) calculations are employed to confirm the formed structures on the TMS. In addition, we have successfully intercalated Si-layer at the interface between the formed graphene and the Ru(0001). The intercalation mechanism has been clarified with STM observations at an atomic level and the DFT calculations. We expect that these new 2D crystals materials will show very interesting physical property and its promising potential applications in nanoscale devices.

In collaboration with Y.L. Wang, S.X. Du, H.M. Guo, L. Huang, H.T. Yang, J.T. Sun, Y. Pan, L. Meng, L.F. Li, G. Li, Y.Q. Wang, X. Wu, L.Z. Zhang, S.R. Song, J.B. Pan et al. from Institute of Physics, CAS; Z.H. Qin from Wuhan Institute of Physics and Mathematics, CAS; S.Y. Zhou from Tsinghua University; S. Pantelides from Vanderbilt University, US; A. Ferrari from University of Cambridge, UK; M. Ouyang from Maryland University, US; W.A. Hofer from the University of Liverpool, F. Liu from University of Utah, US.

References

[1] Y. Pan et al., Adv. Mater. **21** (2009) 2777.
[2] L. Meng et al., Nano Lett. **13** (2013) 685.
[3] L.F. Li et al., Nano Lett. **13** (2013). 4671.
[4] L.F. Li et al., Adv. Mater. **26** (2014) 4820.
[5] Y.L. Wang et al., Nano Lett. **15** (2015) 4013.
[6] G. Li et al., J. Am. Chem. Soc. **137** (2015) 7099.
[7] Y.Q. Wang et al., Adv. Mater. DOI: 10.1002/adma.201600575 (2016).

Figures