ITC Research Student Seminar 2016-17

Date : 26 June 2017 (Monday)
Time : 4:00 pm – 5:00 pm
Venue : Room ST602, 4D Theatre, The Hong Kong Polytechnic University

Speaker : HUI Chi Yuen (PhD Student)
Topic : Developing flexible conductive synthetic fabrics for wearable electronics

Speaker : NG Sze Wing (PhD Student)
Topic : Transferable and Functional Graphene-based 2D Objects

Abstracts

Topic: Developing flexible conductive synthetic fabrics for wearable electronics

Over the past years, considerable effort has been devoted to the development of alternative energy storage/conversion devices with high power and energy densities because of the ever-increasing environmental problems and the up-coming depletion of fossil fuels. As an intermediate system between dielectric capacitors and batteries, supercapacitors have attracted a great deal of attention owing to their higher power densities relative to secondary batteries. Furthermore, they are maintenance-free, possess a longer life cycle, cope with a simple charging circuit, experience no memory effect, and are generally much safer. In this project, a new structure of capacitor based on flexible fabrics will be developed. This new approach will improve the flexibility of the developed capacitor which will be viable in future textile materials. A prototype conducting synthetic fabric, like polyester will be prepared as a substrate to become the base electrode of the capacitor. A capacitive layer will be grown on the conducting surface. Afterwards, a top-up electrode will be deposited on the top layer to make the whole fabrics to become a capacitor structure.

Topic: Transferable and Functional Graphene-based 2D Objects

Graphene, the single-atom- thick honeycomb lattice made up of carbon atoms, is the latest found member in the carbon allotrope family and popular for a series of unique properties such as the ultra-high mechanical flexibility and durability, superb optical transparency, high thermal conductivity; stability to air and moisture; extremely high charge carrier mobility at room temperature as well as obtaining a zero band gap[3-5]. They have been applied on diversified aspects, such as separation membranes, smart surfaces, flexible sensors and energy harvesting/ storage devices[1,2]. However, pure graphene is actually hydrophobic; being biochemically inert and its zero band gap would also resulted in current leakage and power dissipation when applied on standard logic circuits. To circumvent the above problems, multiple modification steps on graphene are necessary prior to its practical incorporation into devices or matrices specific requirement on electronic properties, sensitivities and reactivity to the target reactants.

Here we report the fabrication and application of several functional and transferrable graphene based 2D materials. A number of functional polymer brushes were grown on the surface of mono to few- layer CVD graphene sheets via non-covalent π-π stacking interactions thus no harsh reaction environment was required; on the other hand, various thin film metal/ metal oxide@graphene 2D objects were prepared via robust physical deposition method. Importantly, these approach of graphene surface modification would not destruct the natural structure of graphene layer.

All of the fabricated samples are light-weight, flexible, patternable and transferrable. The polymer brushes tethered on the graphene surface provide desirable chemical and biological responsive groups; a wide variety of functionalities can be achieved by simply changing the types of immobilized polymer brushes. The applications of these polymer@graphene 2D objects were demonstrated by the smart control of surface wettability and immobilizing DNA oligonucleotide arrays. Meanwhile, the graphene supported metallic thin films also shown satisfactory conductivity and enhanced flexibility when compared to pure ones; thus they were used for further fabrications of energy harvesting devices.

References :

[1] COLSON, J. W. & DICHTEL, W. R. 2013. Rationally synthesized two-dimensional polymers. Nature Chemistry, 5, 453-465.

[2] KISSEL, P., ERNI, R., SCHWEIZER, W. B., ROSSELL, M. D., KING, B. T., BAUER, T., GOETZINGER, S., SCHLUETER, A. D. & SAKAMOTO, J. 2012. A two-dimensional polymer prepared by organic synthesis. Nature Chemistry, 4, 287-291.

[3] GEIM, A. K. & NOVOSELOV, K. S. 2007. The rise of graphene. Nature Materials, 6, 183-191.

[4] BAE, S., KIM, H., LEE, Y., XU, X., PARK, J.-S., ZHENG, Y., BALAKRISHNAN, J., LEI, T., KIM, H. R., SONG, Y. I., KIM, Y.-J., KIM, K. S., OZYILMAZ, B., AHN, J.-H., HONG, B. H. & IIJIMA, S. 2010. Roll-to-roll production of 30-inch graphene films for transparent electrodes. Nature Nanotechnology, 5, 574-578.

[5] LEE, C., WEI, X., KYSAR, J. W. & HONE, J. 2008. Measurement of the elastic properties and intrinsic strength of monolayer graphene. Science, 321, 385-388.

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