**Optical Bio-chemical Sensing by 2D Materials**

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Two-dimensional (2D) materials including graphene and transition metal dichalcogenides (TMDs) possess tunable optical properties (i.e. photoluminescence emission and Raman scattering) that is sensitive to molecular doping. Here we decorate exfoliated graphene with one of azobenzene derivatives: methyl orange (MO) and investigate its doping effects in graphene via spatially resolved Raman spectroscopy. Thickness-dependent doping effects are distinctly evidenced through G band evolution in Raman spectra.1 Moreover, we probe the reversible molecular structural transition of azobenzene on graphene driven by UV/white light irradiation. Considerable reduction of the doping level in graphene and chemical enhancement of the molecular signal are witnessed when trans-azobenzene isomerizes to the cis configuration.2 Beyond graphene, we also reveal how the molecular adsorption can modulate the photoluminescence (PL) emission of monolayer WS2. The PL intensity is strongly enhanced upon electron-withdrawing molecules adsorption, due to P-type doping induced increase of the neutral exciton formation.3 The types of dopant molecules are further expanded to H2O and DNA nucleobases,4 as cornerstones for humid sensor and DNA sequencing. Our spectroscopic studies indicate rich possibilities for building 2D materials based flexible bio-chemical sensors.

**Reference**

1. Peimyoo, N.; Yu, T.; Shang, J.; Cong, C.; Yang, H. Thickness-dependent azobenzene doping in mono-and few-layer graphene. *Carbon* **2012**, *50*, 201-208.

2. Peimyoo, N.; Li, J.; Shang, J.; Shen, X.; Qiu, C.; Xie, L.; Huang, W.; Yu, T. Photocontrolled molecular structural transition and doping in graphene. *ACS Nano* **2012**, *6*, 8878-8886.

3. Peimyoo, N.; Yang, W.; Shang, J.; Shen, X.; Wang, Y.; Yu, T. Chemically Driven Tunable Light Emission of Charged and Neutral Excitons in Monolayer WS2. *ACS Nano* **2014**, *8*, 11320-11329.

4. Feng, S.; Cong, C.; Peimyoo, N.; Chen, Y.; Shang, J.; Zou, C.; Cao, B.; Wu, L.; Zhang, J.; Eginligil, M.; Wang, X.; Xiong, Q.; Ananthanarayanan, A.; Chen, P.; Zhang, B.; Yu, T. Tunable excitonic emission of monolayer WS2 for the optical detection of DNA nucleobases. *Nano Res.* **2018**, *11*, 1744-1754.

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Ting YU received his PhD in Department of Physics, National University of Singapore in 2003 and currently is a Professor in Division of Physics and Applied Physics, Nanyang Technological University, Singapore. Dr YU has received many prestigious awards including Nanyang Excellence Award for Research and Innovation (2008), National Young Scientist Award, National Research Foundation Fellowship Award (2009), Outstanding Young Scientist for the 3rd Inter Academy Panel/World Economic Forum (Summer Davos Forum) ((IAP/WEF, Representative of Singapore, 2010) and Institute of Physics Singapore, Nanotechnology award (2011). His research interests cover fabrication of low dimensional, especially 2D materials and investigation of their optical, optoelectrical and electrochemical properties for developing novel electronics, optoelectronics and energy conversion/storage devices. Dr Yu has published more than 260 SCI papers and received over 18,500 non-self-citations. His H-index is 73.



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