THE CHINESE UNIVERSITY OF HONG KONG
Department of Electronic Engineering

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Photonics and Optoelectronics of 2D Materials

By

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Abstract:

Here we would like to review our recent progresses on the photonic and optoelectronic applications of graphene and other two-dimensional (2D) layered materials.[1,2] Firstly, we develop a serials of new saturable absorbers based on graphene heterostructures and other 2D materials, including graphene/Bi_2Te_3[3], black phosphorus[4] and self-doped plasmonic 2D Cu3-xP nanosheets[5] as well as 2D halide perovskite [6]. Depending on their nonlinear optical properties, both high energy Q-switched laser and ultrafast mode-locked pulse generation were demonstrated. Secondly, in order to fabricate improved graphene photodetectors, we combine graphene with other 2D materials with high optical gain and achieve highly responsive photodetection in different wavelength ranges, *e.g.*, graphene/perovskite for visible light detection [7], graphene/$MoTe_2$ for near infrared light detection and graphene-Bi_2Te_3 for broadband infrared light detection [9]. Furthermore, we developed new methods to grow and transfer large area single crystal WS_2 [10], large area MoS_2/WS_2 heterojunction [11], and monolayer-bilayer WSe_2 heterojunction [12], and demonstrated their applications for highly responsive photoelectric devices. Thirdly, we investigated plasmonic excitation and THz modulation in graphene/Bi_2Te_3[13], graphene nanoribbon [14] and 3D graphene [15] using either spectroscopic or real space imaging techniques. The important discoveries include the plasmonic coupling of two Dirac materials [13], excitation of high-order mode [15] and edge chirality-related plasmonic broadening [14]. Last, we report our recent progress on the synthesis of 2D organic-inorganic hybrid perovskite nanosheets as well as their optoelectronic applications.[16-22] In summary, the advances of photonics of 2D materials may pave the way for the integration of next generation hybrid silicon photonic circuit.

Keywords: graphene; photonics; optoelectronics, 2D materials.

Reference

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Biography:

Dr. Qiaoliang Bao received his Bachelor (2000) and Master (2003) degree from School of Materials Science and Engineering, Wuhan University of Technology, and Ph. D degree from Wuhan University (2007). From 2008 to 2012, he has been working on graphene photonics in Graphene Research Centre, National University of Singapore (NUS). He was enrolled into Thousand Young Talents Program, China in 2012. In 2016, he was awarded Australia ARC Future Fellowship and is now appointed as Associated Professor at Department of Materials Science and Engineering, Monash University, Australia. His main contributions include the inventions of graphene-based mode-locked laser and graphene broadband polarizer. Dr. Bao's current research interests are: 1) advanced low-dimensional optical materials and fundamental understanding of their optical properties; 2) photonic and optoelectronic devices based on 2D materials including graphene, h-BN, layered transition metal dichalcogenides, topological insulators, and perovskites. He has authored or co-authored more than 140 refereed journal articles with more than 15,000 total citations and an H-index of 49 according to Google scholar.

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