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Han Zhang, Edmund Kelleher, Juejun Hu, "2-D Materials for Optics and Photonics," *Opt. Eng.* **55**(8), 081301 (2016), doi: 10.1117/1.OE.55.8.081301.

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Throughout the last decade, interest has grown significantly in the photonic applications of 2-D materials since the emergence of graphene. The unique optical and electronic properties of graphene, including broadband absorption, high electron mobility, and ultrafast carrier dynamics, qualify graphene as a next-generation platform for advanced optoelectronic devices. In addition to semimetallic graphene, topological insulators, semiconducting transition metal dichalcogenides, and insulating hexagonal boron nitride have emerged, offering similarly fascinating, yet distinct, optical properties. Recently, 2-D layered black phosphorus (BP) has been found to interact strongly with light, while possessing a layer-dependent direct bandgap, adding to the catalog of 2-D crystalline materials with highly tunable properties suitable for photonic applications. The breadth of available 2-D materials, including wide-bandgap insulators, narrow-bandgap semiconductors, metals, semimetals, and topological insulators, supports operation covering a wide range of frequencies from the visible to the microwave region. As such, 2-D materials have enabled revolutionary breakthroughs in optical sciences, and represent a new paradigm for the development of advanced optical devices. Intense research progress in the field in a relatively short period of time has necessitated this special section on 2-D materials for optics and photonics that aims to summarize recent research in this area, while highlighting cutting-edge results.

This special section presents 18 papers by internationally recognized research teams, addressing a wide range of recent advances in photonic technologies based on 2-D materials. A significant number of the papers in this special section are devoted to investigating the light-matter interaction in 2-D materials and its applications for nonlinear optics, ultrafast phenomena, particularly in femtosecond pulse generation.

Zhen Shang et al. demonstrate the first experimental study tuning the nonlinear optical property of graphene by applying ion irradiation. They theoretically and experimentally investigate the deformation of graphene layers and observe that after irradiation, the space between separate graphene layers can be reduced, further enhancing the interaction of the graphene with the evanescent optical field. This interesting study suggests wide applications for modulation of the nonlinear optical property of 2-D materials beyond graphene.

Hongtong Zhu et al. fabricate a uniform-quality large-area monolayer graphene saturable absorber (SA) with a sandwich structure, and employ this device to achieve sub-picosecond pulse mode-locking of a diode-pumped $Yb{:}Y_2SiO_5$ laser. Their results suggest that low-cost high-quality graphene SAs offer a practical route to achieving stable high-power ultrafast mode-lock laser systems.

A new approach for the fabrication of BPSAs is developed by Yao Chen et al. using an optically driven technique to directly deposit on the facet of an optical fiber. The BP saturable absorber supports mode locking at a stable repetition of 1.843 MHz, with a pulse duration of 117.6 ns. Zhiteng Wang et al. also report on the broadband saturable absorption property of graphene—Bi_2Te_3 heterostructures, demonstrating their application as a harmonic mode-locker. The results suggest that graphene—Bi_2Te_3 heterostructures can serve as a highly nonlinear photonic device for practical applications.

Jakub Bogusławski et al. report on the generation of 152-nJ Q-switched pulses in all-polarization-maintaining Er-doped fiber lasers. The laser is passively modulated by an antimony telluride layer sputtered on the surface of a side-polished fiber, through exploiting the evanescent field interaction with the optically nonlinear material. The laser cavity comprises a simple design, forming a robust, compact, and stable source of short pulses.

Bo Guo and Yong Yao experimentally demonstrate a tunable triple-wavelength mode-locked erbium-doped fiber laser utilizing a few-layer topological insulator: Bi_2Se_3/polyvinyl alcohol solution. Their triple-wavelength mode-locked fiber laser could be applied in areas including optical communications, biomedical research, and sensing systems.

Dazhi Lu et al. demonstrate a passively Q-switched Yb^{3+}-doped $ScBO_3$ bulk laser using a BPSA. Their results suggest that BP has the potential to be deployed as a broadband optical switcher from the visible to midinfrared spectral range, in both fiber and bulk laser systems.

Zhengqian Luo et al. report graphene mode-locked or Q-switched Tm/Ho-codoped fiber laser pumped by a 1212-nm phosphorus-doped fiber Raman laser, which might be the first demonstration of 2-μm pulsed fiber lasers that is efficiently pumped by a 1212-nm laser.

Junsu Lee et al. experimentally demonstrate that a bulk-structured Bi_2Te_3 topological-insulator (TI)-based saturable absorber can be used with a dissipative soliton resonance—based nanosecond-pulse fiber laser. Their results show that temporal width-tunable mode-locked pulses can readily be produced through the dissipative soliton resonance effect from an erbium-doped fiber ring cavity into which a bulk-structured Bi_2Te_3 TI-deposited side-polished fiber has been incorporated.

Zhi-Chao Luo et al. demonstrate a pulsed erbium-doped fiber laser (EDFL) based on a few-layer MoS_2-SA, which was fabricated into a film structure by evaporating the mixture of MoS_2 nanosheets and polyvinyl alcohol. The results further demonstrate the excellent saturable absorption ability of few-layer MoS_2 at telecommunication waveband.

Yixuan Xie et al. experimentally demonstrate a passively Q-switched Tm-doped YAG ceramic laser with BPSA. The generated Q-switched pulse has a maximum average power of 38.5 mW and pulse energy of 3.32 μJ at 2 μm wavelength, showing that BP is a promising SA for infrared-pulsed lasers.

Hao Chen et al. fabricate fiber-integrated tungsten disulfide SA devices with the interesting merits of compactness and reliability. They achieve stable mode-locking and Q-switching states in their laser configuration using the fiber-integrated tungsten disulfide SA devices. The fabrication technique allows control over the ratio of different elements in the fabricated 2-D material film, and also allows the growth of different 2-D materials to build super-lattices or heterostructure-type photonic devices with artificially engineered band-gap and thickness, thus paving the way for the development of new photonic devices such as SAs for pulsed laser technology.

Acknowledgments

We would like to thank Michael T. Eismann, Editor-in-Chief of *Optical Engineering*, for the opportunity to publish this special section, and Zhaohui Li and SPIE staff for their great support during the whole preparation process. We also appreciate the great efforts from all of the reviewers who gave detailed reviews and suggestions to the manuscripts submitted to this issue. Lastly, the three editors feel very grateful to all the authors for their excellent contributions to this special section and we anticipate that all the papers will provide readers with a wider knowledge about the recent developments in the optics of 2-D materials.

Han Zhang is a distinguished professor of photonics at Shenzhen University, China. He received his BS degree from Wuhan University and his PhD degree from Nanyang Technological University. He is the winner of the National Thousand Talents Program for Distinguished Young Scholars, a government endowed professorship, and the National Science Fund for Excellent Young Scholars and the New Century Excellent Talent Award, MOE, China. His current research is focused on ultrafast and nonlinear photonics of 2-D materials. He has published more than 100 papers with more than 6000 total citations. He is also the director of Shenzhen Key Laboratory of Two-Dimensional Materials and Devices/Shenzhen Engineering Laboratory of Phosphorene and Optoelectronics.

Edmund Kelleher is a Royal Academy of Engineering Research Fellow in the Department of Physics, Imperial College London. After receiving his PhD in physics from Imperial in 2012, he became an EPSRC Doctoral Prize Fellow. In 2013 he was awarded a research fellowship from the Royal Academy of Engineering. His research lies at the interface of fundamental and applied nonlinear optics, targeting the development of versatile pulsed lasers. He also has an interest in the optical properties of nanomaterials for the development of advanced photonic devices. In 2015 he was awarded the Paterson Medal by the Institute of Physics.

Juejun Hu received his PhD from MIT in 2009 and is currently an associate professor in the Department of Materials Science and Engineering at MIT. His primary research interest focuses on the enhanced photon-matter interactions in nanophotonic structures, covering materials and devices for sensing, magneto-optics, photovoltaics, and spectroscopy. He has authored and coauthored over 60 refereed journal publications.