Glass-on-2-D-material Photonics

Hongtao Lin[1], Yi Song[2], Yizhong Huang[1], Lan Li[1], Junying Li[1], Spencer Novak[3], Anupama Yadav[3], Chung-Che Huang[4], Daniel Hewak[4], Kathleen Richardson[3], Jing Kong[2], Juejun Hu[1]

[1]Department of Materials Science & Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, USA
[2]Department of Electrical & Computer Science Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, USA
[3]The College of Optics & Photonics, University of Central Florida, Orlando, Florida, 32816, USA
[4]Optoelectronics Research Centre, University of Southampton, Southampton, UK
hometown@mit.edu

Due to their extraordinary optoelectronic properties, 2-D materials have been identified as promising materials for integrated photonics. However, most 2-D material-integrated photonic devices demonstrated to date are fabricated by transferring a layer of 2-D material on top of already fabricated photonic structures, which limits full utilization of their capability. Here we introduce a new photonic integration approach via direct deposition and fabrication of chalcogenide glass photonic devices on 2-D materials. We have applied the new process to fabricate high-performance, broadband on-chip graphene-based optical polarizers with a high contrast ratio of 740 dB/cm leveraging the remarkable optical anisotropy of graphene, and thermo-optic switches with a record heating efficiency of 10 nm/mW using in-waveguide low-loss (20 dB/cm) graphene transparent electrodes. The low processing temperatures of chalcogenide glasses further enables monolithic integration on plastics and the first waveguide-integrated graphene photodetector on flexible substrates. Last but not least, we have also demonstrated monolithic integration of chalcogenide photonic components on several other 2-D materials including WSe_2, WS_2, and $MoTe_2$. The glass-on-2-D-material approach therefore provides a facile universal route for photonic integration based on 2-D materials.