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GUEST EDITORIAL

# Special Section Guest Editorial: Phase-Change Reconfigurable Photonics

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Phase change materials (PCMs), compounds that exhibit large optical property contrast upon a structural phase transition, have been widely hailed as one of the most promising routes to realizing reconfigurable photonic devices and circuits.[1,2] Compared to traditional optical tuning mechanisms, such as electrooptic and thermo-optic modulation, PCM-enabled reconfigurable photonics feature the advantages of ultra-compact footprint and low energy consumption, and have already found broad applications in computing, communications, imaging and sensing. This special section highlights several recent advances in this exciting area.

Benefitting from its small thermal mass and out-of-plane thermal resistance, graphene has been recognized as a high-performance resistive heater material for thermal switching of PCMs.[3,4] Liu et al.[5] reported multi-level switching of $Sb_2Se_3$, a low-loss PCM,[6] using graphene micro-heaters. The device's optical response could be switched for more than 30,000 cycles, which represents a major cycle endurance improvement over the prior state-of-the-art. Waveguide phase shifters and interferometer optical switches were further experimentally implemented based on this platform. Khoi et al.[7] proposed a PCM photonic switch similarly based on $Sb_2Se_3$ and graphene heaters, and showed through simulations that its switching energy can be as low as 21 nJ.

Pan et al.[8] explored an optical metasurface design using $Sb_2Se_3$ to realize a tunable waveplate. The metasurface switched from a half waveplate to a quarter waveplate following the amorphous to crystalline transition of $Sb_2Se_3$. Remarkably, the design maintains consistent performance across a wide range of rotation angles.

Sharma et al.[9] investigated liquid-phase solution deposition of $Sb_2Se_3$ films and the resulting film properties. Compared to vapor phase deposition methods, which are commonly used to form PCM films, their reported solution processing technique offers a versatile and scalable alternative to prepare PCM films.

Instead of using low-loss PCMs such as $Sb_2S_3$[10] and $Sb_2Se_3$,[6] Chen et al.[11] proposed a novel design containing multiple individually controlled phase shifter segments to overcome losses resulting from the technologically mature (albeit optically absorbing) PCM, $Ge_2Sb_2Te_5$ (GST). According to their modeling, the design can yield a low insertion loss just 1.2 dB in a $2 \times 2$ multi-level switch configuration.

Shafiee et al.[12] performed a systematic analysis of photonic memory designs based on Si and SiN waveguides co-integrated with PCMs including GST and $Ge_2Sb_2Se_4Te$ (GSST).[13] Their multi-physics simulation models indicate that, compared to silicon nitride waveguides, employing silicon waveguides coupled with PCMs can result in a more reliable solution with lower optical scattering loss and enhanced bit density per cell.

In their paper, Hu et al.[14] designed a multilayer thin film device incorporating the electrochromic ionic conductor $WO_3$. By leveraging a Fabry-Pérot optical stack design, a solid-state electrochromic device with high color brightness and saturation was demonstrated.

We thank the authors for contributing to this special section, which covers a diverse cross-section of topics related to reconfigurable photonics based on phase change materials. We hope that this special section will help spur further interest and investigations in this dynamic field.

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