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Li Lu[1], Ramon Paniagua-Dominguez[2], Vytautas Valuckas[2], Arseniy I. Kuznetsov[2], Yuqing Jiao[3], and Robert E. Simpson[1]

[1]Singapore University of Technology and Design (SUTD), 487372, Singapore
[2]Institute of Materials Research and Engineering, A*STAR (Agency for Science, Technology and Research), 138634, Singapore
[3]Eindhoven University of Technology, Eindhoven 5600MB, The Netherlands

In recent years, phase change materials (PCMs) have attracted attention for tuneable photonic applications [1]. Comparing to other materials with tuneable optical properties, such as liquid crystals and electrochromics, PCMs can have a larger optical contrast between states and the switching speed can be substantially faster, on a sub-ns scale [2]. Moreover, the phase transition in PCMs is a non-volatile process, which means it retains the switched optical properties without a continuous energy supply. The most commonly used PCM, $Ge_2Sb_2Te_5$ (GST), has a large refractive index in the near infrared (NIR) spectrum and exhibits a large contrast between its amorphous and crystalline structural states. However, it is extremely lossy for wavelengths shorter than 2000 nm. This renders the material impractical for many photonics applications in the visible and NIR spectrum. In comparison, we introduce a wide band gap phase change material, Sb_2S_3, which has a refractive index of approximately 3.0 and 3.5 at NIR frequencies for the amorphous and crystalline states respectively. The band gap is 2.0 eV for amorphous state and 1.7 eV for crystalline state [3]. Thus, the extinction coefficient is near 0 for wavelengths beyond 600 nm in the amorphous state and beyond 800 nm in the crystalline state. Also, this material is capable of reversible switching and crystallization in 70 ns [3]. Thus, Sb_2S_3 has the potential for tuneable visible and NIR photonics applications.

In this talk, two different types of Sb2S3 reprogrammable photonics devices will be introduced. Firstly, I will discuss all dielectric Sb_2S_3 nanoantenna arrays based on a Huygens' metasurface [4] for visible and NIR spectrum. This device operates in transmission mode and can dynamically bend the transmitted light at a wavelength of 840 nm by an angle of 10˚. Secondly, I will show how this same material can be used to programmable route 1550 nm light through InP on-chip waveguides. These two demonstrations suggest that PCMs have further applications beyond data storage for reprogrammable visible and NIR light routers and beam steerers.

Reference

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