

Sb2S3 phase change tuneable photonics

Citation for published version (APA):

Lu, L., Paniagua-Dominguez, R., Valuckas, V., Kuznetsov, A. I., Jiao, Y., & Simpson, R. (2019). Sb2S3 phase change tuneable photonics. 52-53. Abstract from IPS meeting 2019, Singapore, Singapore.

Document status and date:

Published: 01/01/2019

Document Version:

Accepted manuscript including changes made at the peer-review stage

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy

If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Sb₂S₃ phase change tuneable photonics

Li Lu¹, Ramon Paniagua-Dominguez², Vytautas Valuckas², Arseniy I. Kuznetsov², Yuqing Jiao³, and Robert E. Simpson¹

¹Singapore University of Technology and Design (SUTD), 487372, Singapore

²Institute of Materials Research and Engineering, A*STAR (Agency for Science, Technology and Research), 138634, Singapore

³Eindhoven 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 Sb_2S_3 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

[1] Wuttig, M., H. Bhaskaran, and T. Taubner. "Phase-change materials for non-volatile photonic applications." *Nature Photonics* 11.8 (2017): 465.

[2] Waldecker, Lutz, et al. "Time-domain separation of optical properties from structural transitions in resonantly bonded materials." *Nature materials* 14.10 (2015): 991.

[3] Dong, Weiling, et al. "Wide Bandgap Phase Change Material Tuned Visible Photonics." *Advanced Functional Materials* (2018): 1806181.

[4] Yu, Ye Feng, et al. "High-transmission dielectric metasurface with 2π phase control at visible wavelengths." *Laser & Photonics Reviews* 9.4 (2015): 412-418.