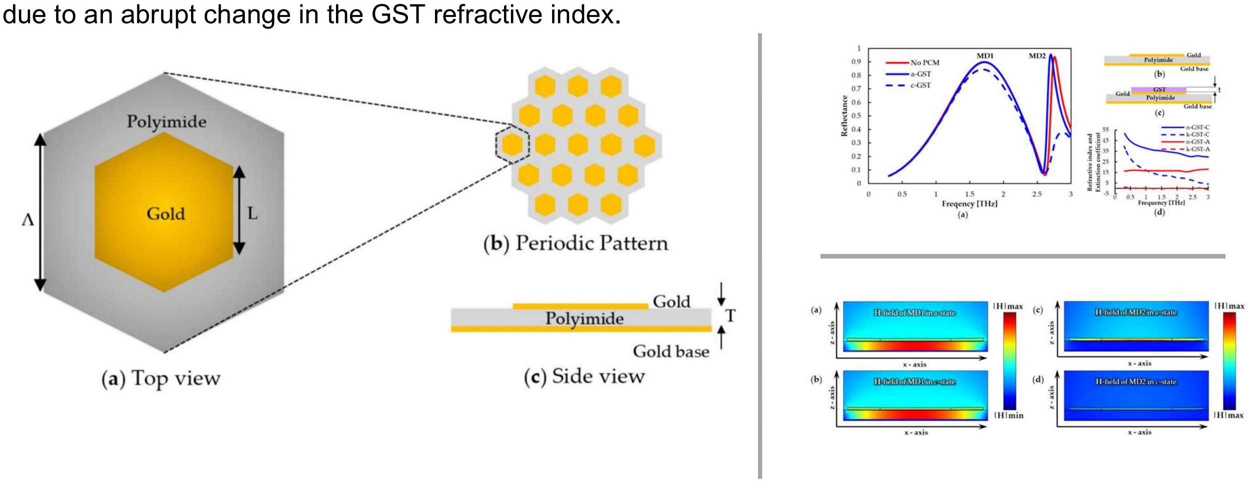
Reflective Terahertz Metasurfaces Based on Non-Volatile Phase Change Material for Switchable Manipulation

*Natsima Sakda , **Ratchapak Chitaree,** B. M. Azizur Rahman*

Rationale and objective: Recently, metasurfaces have been investigated and exploited for various applications in the THz regime, including modulators and detectors. However, the responsive properties of the metasurface in THz stay fixed once the fabrication process is complete. This limitation can be modified when integrating the phase change material (PCM), whose states are switchable between crystalline and amorphous, into the metasurface structure. This characteristic of the PCM is appealing in achieving dynamic and customizable functionality. In this work, the reflective metasurface structure is designed as a hexagonal unit deposited on a polyimide substrate. The non-volatile PCM chosen for the numerical study is germanium antimony tellurium (GST).

Summary: In this research, we firstly simulated a hexagonal metasurface with no PCM. The numerical result shows that the proposed structure provides two unique resonant frequencies in THz radiation with high values of reflectivity: 1.71 and 2.76 THz. After that, the phase change material, GST, was integrated into the proposed unit cell structure by placing it on top of the gold film. Initially, the amorphous state of GST was considered. The unit cell of the phase change metasurface provides two fixed resonant frequencies of 1.72 and 2.70 THz with a high reflectivity, and one of them still has high reflectance values after the phase transition. The field distributions of these two peaks clearly show differing magnetic field contours as identified by the magnetic dipoles (MD1 and MD2). The former is located in a polyimide layer, while the latter is confined in the GST layer. After the phase transition of GST from amorphous to crystalline state occurs, there is a minimum change in MD1. In addition, MD2 is found to be confined in the GST layer due to an abrupt change in the GST refractive index.



Graphical summary: The summarized figure of the active metasurface reflector embedded with GST in THz radiation.

Outcome: Our proposed phase change metasurface provides two resonant frequencies located at 1.72 and 2.70 THz, respectively; one of them shows a high contrast of reflectivity at almost 80%. The effects of geometrical parameters, incident angles, and polarization modes on the properties of the proposed structure are explored. Finally, the performances of the structure are evaluated in terms of the insertion loss and extinction ratio.

Related publications:

1. Sakda, Natsima, Ratchapak Chitaree, and B. M. Azizur Rahman. 2022. "Reflective Terahertz Metasurfaces Based on Non-Volatile Phase Change Material for Switchable Manipulation" Photonics 9, no. 8: 508. https://doi.org/10.3390/photonics9080508

Preferred : https://physics.sc.mahidol.ac.th/research/highlight/R-Chitaree-2022-6