Actively Reconfigurable Metasurfaces for Dynamic Optical Components

VANDERBILT UNIVERSITY
CTTC Center for Technology Transfer & Commercialization

Summary

Phase change materials (PCMs) are a fascinating class of materials that can change certain material properties (e.g., absorbance or reflectivity) upon the application of a stimulus. Researchers at Vanderbilt University have used a PCM to create a novel metamaterial that can be reconfigured for use in a wide range of potential optical and integrated photonic applications from the infrared to terahertz spectral domain.

Addressed Need

Current nanophotonic and metamaterial elements are characterized by high absorption loss and short propagation lengths, which result in low throughput and an inability to sufficiently control light propagation. The present material overcomes these limitations and offers very high spatial precision, while minimizing optical absorption. This metamaterial could be used in one instance as a waveguide receiver, and then actively reconfigured on the fly by using the PCM properties to refract the signal to another location on the chip. The modular and actively reconfigurable nature of this metamaterial has great promise for a number of applications and fields.

Technology Description

In order to create this material, hexagonal boron nitride (hBN) was layered on top of vanadium dioxide (VO_2) crystals, a PCM. The natural hyperbolic response of hBN enabled this metamaterial device to capitalize upon the subdiffractional, volume confinement of light in hBN with the variable infrared properties of VO_2. Upon application of a stimulus such as heat, electrical current, light pulses, or mechanical stress/strain, VO_2 changes phase from a semiconducting to a metallic state, altering its infrared response. These changes dramatically alter the light moving within the hBN, allowing for active, reconfigurable control of light propagation with nanoscale precision. For example, it is possible to design the material such that it first serves as a lens (see Figure 1), and then could be reconfigured to operate as a waveguide.

Technology Development Status

- Proof of concept experiments have been completed using the VO_2/hBN metamaterial
- Successfully observed planar refraction of polariton propagation within reconfigurable metamaterial device
- Simulations illustrate the metamaterial can be used as a lens, antenna and waveguide

Intellectual Property Status

A patent application has been filed.

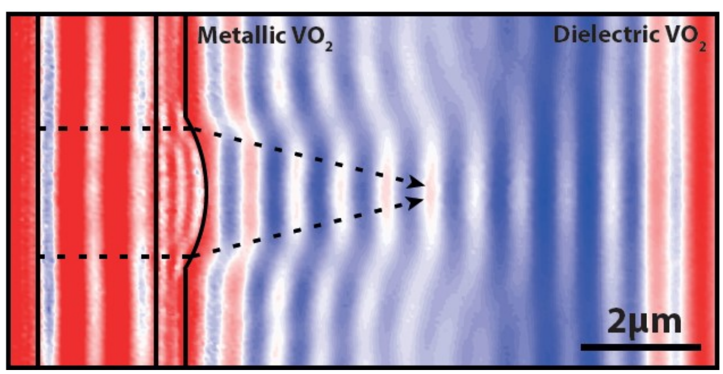

Figure 1: A simulation illustrating how this novel metamaterial can control and refract polaritons through the use of phase change materials, thereby creating an actively reconfigurable surface.

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