Spectral tuning of surface phonon polariton confinement with phase change material for surface enhanced infrared absorption spectroscopy

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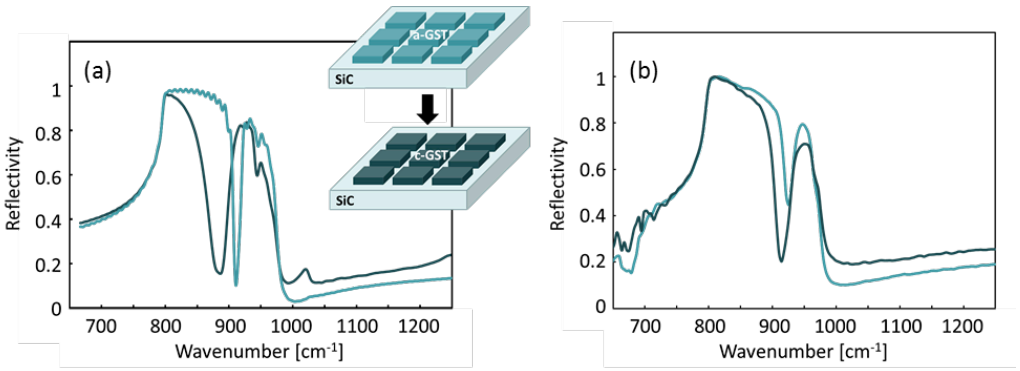
ABSTRACT

Mid-infrared (Mid-IR) spectroscopy has been extensively used for chemical sensing of organic species based on the analysis of their vibrational modes that serve as unique fingerprints. The applications include biological sensing, detection of air pollution, food safety, and medical diagnostics, especially extending to breath test for cancer. Among various mid-IR spectroscopic techniques, surface enhanced IR absorption is the most promising approach to obtain advantageously high spectral sensitivity. For efficient surface field enhancement in the mid-IR region, surface phonon polariton (SPhP) in polar dielectricsare attracting attentions due to their extremely lower loss than plasmonic metal. Although the advantage of SPhP is characterized by the narrowband response, it requires fine tunability to match the SPhP absorption band with a specific vibrational mode of target chemical species. In this study, for spectral tuning of SPhP resonance, we propose to employ a chalcogenide phase change material that exhibit a reversible transition between the crystalline and amorphous phases with a huge refractive index contrast. Narrow absorption band and the tunability of SPhP supported by SiC are experimentally demonstrated.

The sample we used in this study is a SiC substrate on which amorphous GeSbTe (GST) layer with a thickness of 80 nm was sputtered. A periodic GST patch (8 μm×8 μm×80 nm) structure was fabricated by femtosecond pulsed laser ablation. Scanning laser heating was used for crystallization of the amorphous patches. IR reflection spectra were measured by a FT-IR spectrometer.

Figure 1(a) shows reflection spectra calculated by the FDTD method for the patches in amorphous and crystalline phases. A narrow absorption band (15 cm-1) and a large spectral shift (30 cm-1) was obtained. The broader absorption band for the crystalline patch comes from the optical loss (absorption) by GST. Figure 1(b) shows experimental reflection spectra. The spectral width was in good agreement with the simulation result, while the smaller shift might be due to imperfect crystallization of GST.



Key words: phonon polariton, polar semiconductors, surface enhanced infrared spectroscopy