Investigation of optical nonlinearity in conformally thin film coated three-dimensional photonic crystals

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Conformal coatings[1] are widely used in microelectronic manufacturing to protect the components and devices from environmental effects. Here, we are going to demonstrate that conformally coated polymeric templates of 3D photonic crystal (PhC) structures[2-4] can be used to enhance nonlinear optical responses. Such configurations in this work provide interesting venues for highly efficient 3D all-optical switching (AOS) for fast and energy-efficient memory devices[5,6].

To improve the refractive index contrast and increase optical nonlinearity of the polymeric template, a conformal coating of a higher nonlinear index material such as MoS_2 or WS_2 thin film[7] is used to coat the 3D polymeric crystals as shown in Fig 1. Fig 2 shows preliminary measurement results for photonic bandgaps (PBGs) of conformally coated woodpile structures with a thin 2nm coating, where a red shift of the fundamental bandgap was observed.

In this conference, non-linear 3D PBGs materials will be characterised with a unique combination of a microscope stage for pressure, vacuum, and temperature control and an in-house built Fourier image spectroscopy (FIS) system for broadband and wide angle-resolved scattering characterization in the visible and infrared range[2]. By pumping with a single frequency laser and varying the pumping power, we can measure the bandgap shift of partial bandgaps as a function of laser power[5,6].

References

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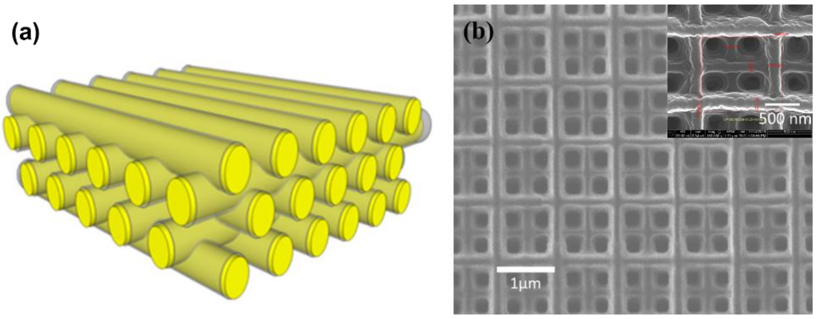

Figure 1. Schematics of (a) thin film MoS_2-coated woodpile template (b) SEM image of the fabricated woodpile template with MoS_2 thin film coating.

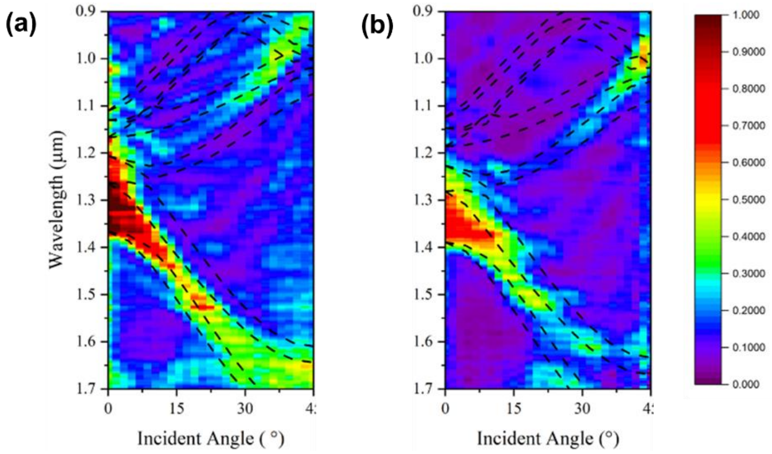

Figure 2. Measured angle-resolved reflection spectra of BCC woodpile structures: (a) non-coated (b) 2nm MoS_2 thin film coated. Dashed lines indicate their corresponding photonic band structures calculated via the plane-wave expansion method.