Supporting information

Large-scale, low-cost, broadband and tunable perfect optical absorber based on phase change material

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Sample Fabrication: While we fabricate the metamaterial absorber, a 100 nm-thick Aluminum (Al) film is first deposited onto the silica substrate. After that, a GST thin film with a well-controlled thickness is further fabricated on the Al film using a radiofrequency (RF) sputtering method. The diameter of the GST target is 4 inch with a 99.99% purity and the deposition rate is 1 Å/S with a power of 30 W. The thicknesses of GST film were determined by the calibrated deposition speed and deposition time and confirmed by AFM measurements. In the following process, an AAO template filled with the well-organized air poles is placed on the GST film. The Al nanoparticles were then constructed on the GST layer via depositing the Al film through the air poles of the AAO template. The pore diameter and inter-pore distance of AAO can be well

controlled by changing the applied voltage and oxidation time of the anodization process (see more details in Ref [1]). Finally, the AAO mask was removed to obtain the final device. In our experiments, the sputtering process of Al or GST was carried out in an argon atmosphere at a pressure of 0.5 Pa. The vacuum chamber pressure was 2.6×10^{-5} Pa.

Characterization and measurement: The morphologies of the fabricated Al NPs were characterized by scanning electron microscopy (SEM; Auriga S40, Zeiss, Oberkochen, Germany). The thickness of the Al film and GST layer were determined by the calibrated deposition and confirmed by AFM measurements. The optical constants of GST film were measured by Variable Angle Spectroscopic Ellipsometry (VASE) using a Woollam M2000 ellipsometer, and a Tauc-Lorentz model was used to fit the measured ellipsometry data. The unpolarized incident light from a tungsten halogen lamp was focused onto the sample by microscope (20x, Olympus, N.A.=0.4), and the reflected light was also collected by the microscope. The reflectance (R) of the fabricated structure at normal incidence was measured using a Si detector and InGaAs detector in the visible and near-infrared regions, respectively. For all the measurements, the incident and collected light were at normal incidence to the sample. The reflection spectra of the samples were normalized to an Al mirror, which is considered 100% reflectivity over the measured range. The absorption spectra (A) is calculated by A = 1- R.

Numerical Simulations: The simulations were performed by commercial software COMSOL Multiphysics, which is based on FEM. The Al NPs were modeled as semi-ellipsoid with a 2 nm-thick homogeneous Al_2O_3 coating, in order to take its oxidization effect into account. The relative permittivity of Al and Al_2O_3 was obtained from Ref [2,3]. All the simulation results were obtained under normal incidence.

References

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