Supplementary information for A Non-volatile Switchable Infrared Stealth Metafilm with GST

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S1: The absorption spectra obtained by transfer matrix method and numerical simulation

We have calculated the optical spectra of the structure by transfer matrix method and numerical simulations, as shown in Figure S1. The two methods get exactly the same results.

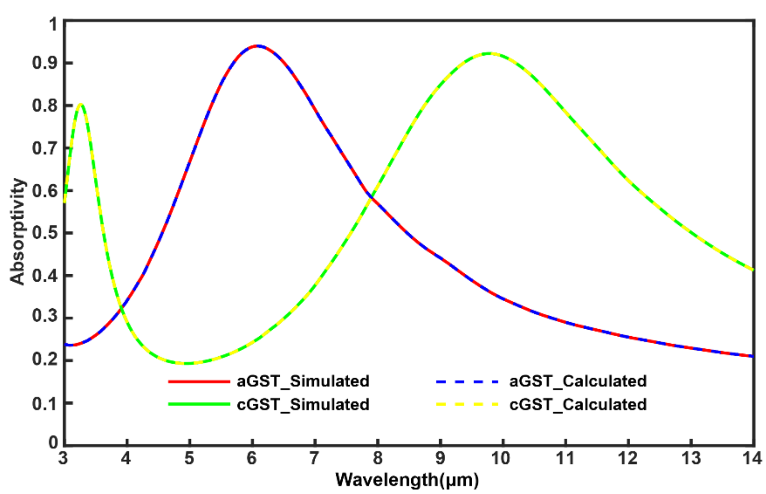

Figure S1. The absorption spectra obtained by transfer matrix method and numerical simulations.

S2: The relative permittivity of the Mo and GST

The relative permittivities of Mo and GST in infrared band were measured by a spectroscopic ellipsometer. There is a significant increase in the real part of the relative permittivity after the phase change from the amorphous state to the crystalline state of GST.

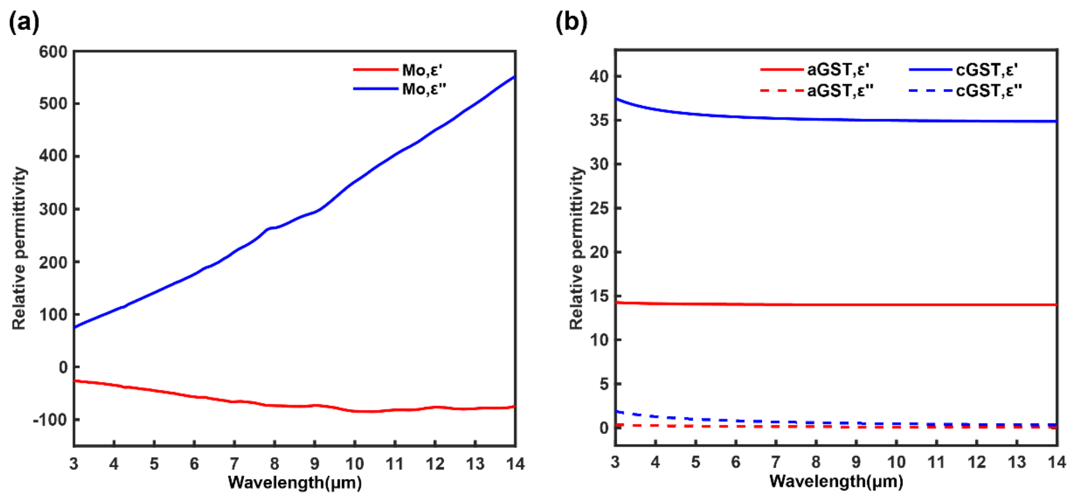

Figure S2. The relative permittivities of the Mo and GST. a, the relative permittivity of Mo at in infrared band measured by the spectroscopic ellipsometer. **b,** the relative permittivity of GST at different states in infrared band measured by the spectroscopic ellipsometer.

S3: The influence of protecting layers on the performance of the metafilm

For practical applications, a protecting layer is generally deposited on the top of phase change materials. The protective layer can prevent the phase change material from being directly affected by the external environment, and improve the stability and performance of the phase change material. To study the influence of the protecting layer, we choose Al2O3 as the protective layer. Its refractive index in the infrared band is about 1.7. We set the thickness of Al2O3 as $30\ nm$, and study the absorption spectra of the new structure through simulation software. Comparing with the absorption spectra of the previous device, as shown in the Figure S3, we can find that adding a protective layer on the top of the structure has little impact on the infrared stealth performance of the structure.

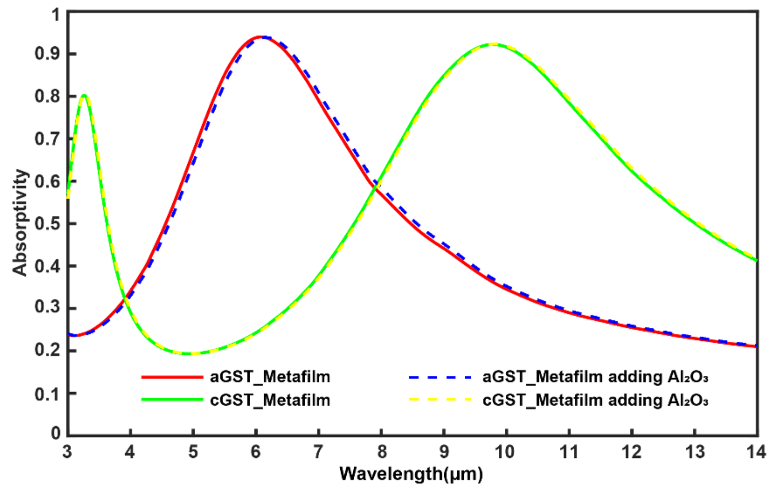

Figure S3. The infrared absorption spectra of the bilayer metafilm and the new device with a protective layer.

S4: The absorption spectra of the device in the visible and near infrared bands

We measured the absorption spectra of the prepared samples in the visible and near infrared bands, as shown in Figure S4. As can be seen from it, when the GST is in the amorphous state, the structure has a relatively high absorption in the visible and near infrared bands, with an average absorptivity of nearly 50%. However, when GST is in the crystalline state, the absorptivity of the sample is significantly decreased, almost half of that in the amorphous state.

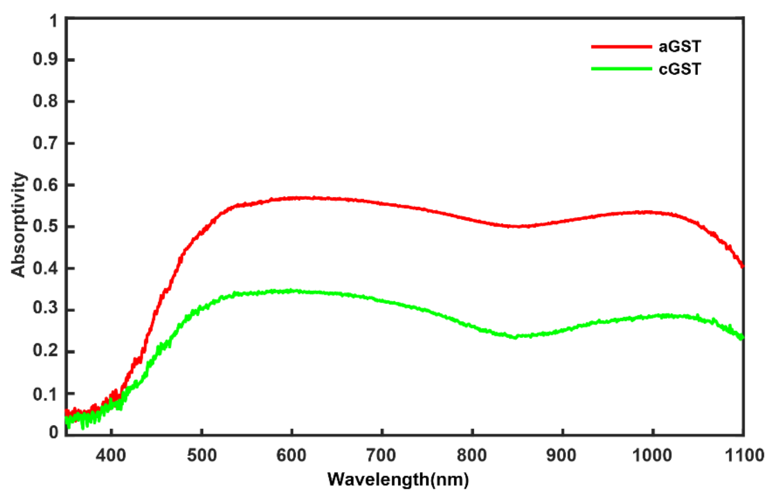

Figure S4. The absorption spectra of the device in the visible and near infrared bands.

S5: The infrared absorption spectra of the fabricated bilayer metafilm

The infrared absorption spectra of the samples at different phase conditions are obtained by a Fourier transform infrared spectrometer (FTIR) as shown in Figure S5(a). Consistent with simulation results, when the GST is in the amorphous state, the film can realize the infrared stealth function matching the atmospheric window, while capable of good radiative heat dissipation capability. But once the GST is transformed into a crystalline state, the absorption spectrum of the entire structure is significantly redshifted, resulting in the huge increase of the infrared radiation of the structure in the 8-14 μm atmospheric window, so that the stealth function cannot be realized.

However, upon comparing the absorption spectra between simulation and experiment, we observe a slight deviation in the experimental measurements when the GST transitions to its crystalline state. Consequently, we conduct further research and the results reveal that there is a significant reduction in the thickness of the upper GST layer of the bilayer films during the transition from amorphous to crystalline phase, which is only about 330 nm compared with the 360 nm before. Therefore, we recalibrate the thickness of GST after the phase transition in the simulation and obtain a new absorption spectrum as shown in Figure S5(b). Notably, following these adjustments, it becomes evident that our sample's measured infrared spectra agree well with our simulation results.

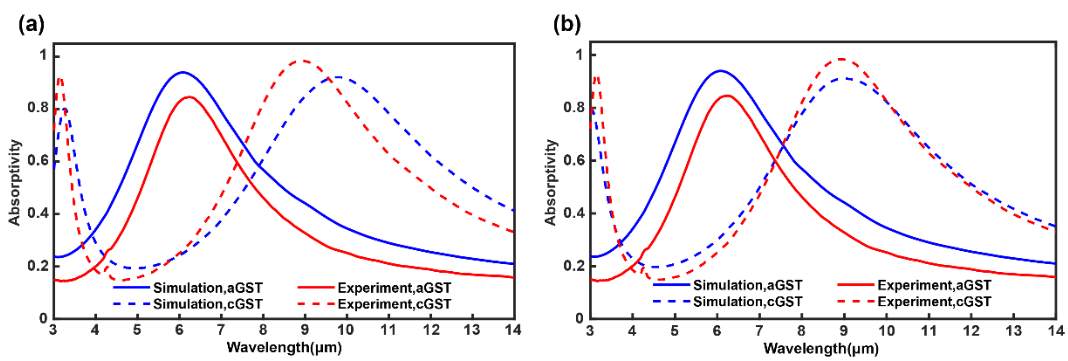

Figure S5. The infrared absorption spectra of the fabricated bilayer metafilm. a, the infrared absorption spectra of the fabricated bilayer metafilm obtained by the Fourier transform infrared spectrometer (FTIR) together with the simulation results. **b,** the infrared absorption spectra of the fabricated bilayer metafilm obtained by the Fourier transform infrared spectrometer (FTIR) together with the adjusted simulation results.