Supporting Information

Broadband polarization-sensitive metamaterial absorber based on ladder network construction in the infrared region

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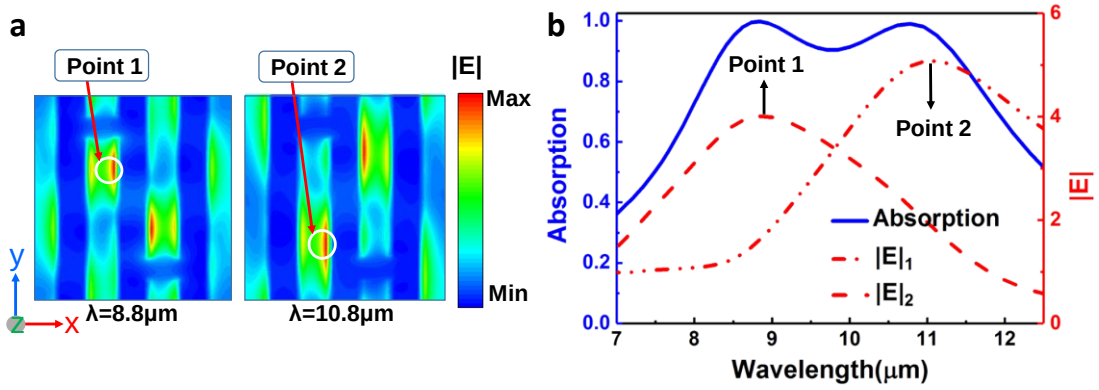

Fig. S1. (a) Electric field distributions of x-y plane at resonance wavelengths. The location of the white circle is the setting position of the point monitor. (b) Absorption spectrum and electric field intensity enhancements as function of incident wavelengths.

In order to further reveal the relationship between the electric field distribution and the response wavelength, absorption spectrum and electric field intensity enhancements as function of incident wavelengths is investigated in Fig. S1. The magnitude of the electric field distributions at 8.8 μm and 10.8 μm is shown in Fig. S1a and the monitor is set in the x-y plane. The point monitors are set at the locations of point 1 and point 2. The relationship between the absorption property and the electric intensity enhancement is investigated in Fig. S1b. It can be found that the maximums of the absorptivity and the electric intensity enhancement can be achieved approximately at the same resonant wavelength. In other words, the resonant wavelength can be obtained when the electric intensity enhancement reaches maximum.

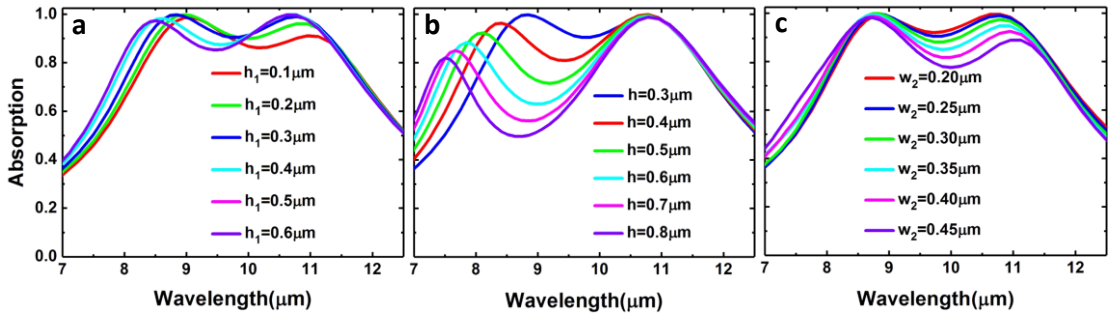

Fig. **S2.** (a) Absorption spectrum in different h_1 values. The h_1 value decides the location of horizontal bar structure in the unit cell. (b) Absorption spectrum in the different height of horizontal bar structure h and (c) the width of horizontal bar

structure w_2.

It is obvious that the field intensity enhancement mainly is located around the horizontal bar part of the unit cell in Fig. S1a. For a comprehensive investigate, the relationship between different geometric parameters of the horizontal bar part and the absorption property of the proposed absorber are investigated in Fig. S2. When one parameter is changed, the others keep constant. The change of h_1 value mainly influence the location of the horizontal bar and the resonance wavelengths are both blue-shifted with h_1 value increased in Fig. S2a. The change of h value mainly influences the height of location of horizontal bar. Thus, the increment only effects the resonance peak at 8.8 μm, in which the response wavelength is blue-shifted and the absorptivity decreases gradually in Fig. S2b. The increment of w_2 value not only influence the width of horizontal bar, but also change the spacing between vertical bars. The response peak at 8.8 μm is slightly blue-shifted. Meanwhile, the absorptivity at 10.8 μm decreases slightly, and the peak position is red-shifted in Fig. S2c. This condition well accords with the calculation results in Figure 2 in the text.

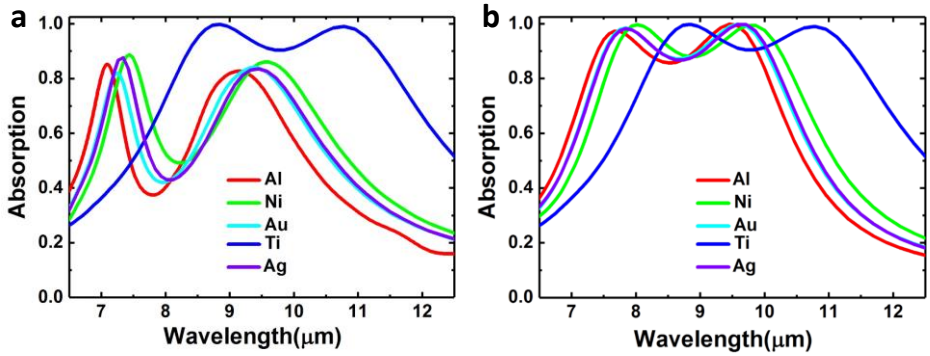

Fig. S3. Relationship between absorption spectrum and different metal materials. (a) Top metal materials (b) Bottom metal materials

The influence of metal materials on the absorption performance for the broadband absorber is investigated in Fig. S3. The effects are analyzed by replacing the top and bottom materials with several common metals, while keeping the structure parameters constant. As a contrast, the designed structure with top Ti ladder network construction and bottom Ti layer is indicated in the spectrum. As depicted in Fig. S3a, the top metal material is replaced by Al, Ni, Au or Ag respectively, while the bottom metal material is always Ti that mainly plays a

reflective role. It is clear that the top metal material has a great influence on performance of metamaterial absorber. In the long wavelength infrared range, when the top material is used Al, Ni Au or Ag, the spectrum exhibits narrow resonance absorption due to the intrinsical narrow bandwidth of plasmonic and small metal loss. The absorption property keeps optimal when the top metal material is Ti. The broad bandwidth corresponds to low-quality factor due to large metal loss. As to the impact of the bottom materials, it is shown in Fig. S3b that the absorption property is slightly changed when the bottom Ti film is replaced by different metals. The bottom layer mainly plays a role in preventing transmission. As for the slight shift of resonance wavelengths, it may be due to the change of equivalent permittivity in the proposed metamaterials.

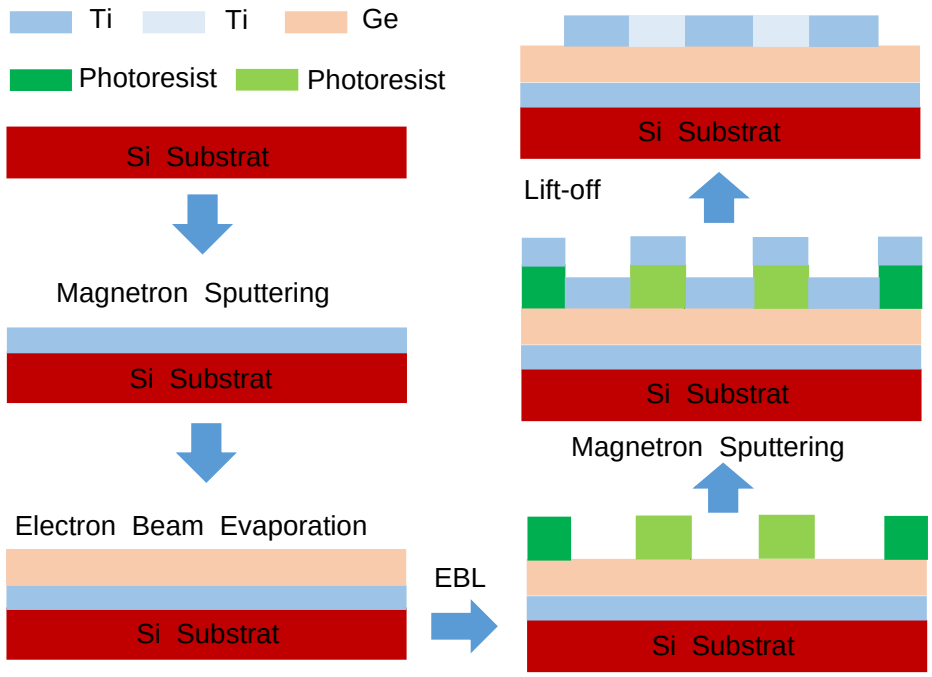

Fig. S4. Technological process diagram of the broadband polarization-sensitive metamaterial absorber.

The fabrication process steps of the absorber include film deposition, photolithography, and lift-off technology. The testing instruments include scanning electron microscope, profilometer and Fourier transform infrared spectrum analyzer, etc. The developed fabrication procedure is shown in Fig. S4. The devices are fabricated on a silicon substrates. Firstly, a Ti film was deposited on silicon substrate by magnetron sputtering. Then, a dielectric layer of

germanium was deposited on the titanium film by electron beam evaporation. Next, spin coating photoresist and subjects the structure to exposure processing by electron beam lithography technology. At this time, a photoresist mask with a pattern was obtained. Afterwards, the titanium film was deposited by electron beam evaporation. Finally, the photoresist on the sample was removed by lift-off technology. After the removal, the designed ladder network construction was finally completed.