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Large Area, Aluminum Metal-Insulator-Metal Infrared Perfect Absorber

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1. Introduction

Metal-insulator–metal (MIM) plasmonic perfect absorbers have been investigated as fascinating structures providing a wide range of applications such as selective thermal emitters [1], [2] and bio sensors [3], [4]. In this present work, we report on a facile approach to fabricate large-area perfect absorber in mid-infrared (MIR) region with aluminum (Al).

2. Results and discussion

The device was fabricated without using photo- and e-beam lithography but adopting reactive ion etching and colloidal lithography techniques.

The parameters of the Al-MIM perfect absorbers, including the periodicity, the thicknesses of the transparent Al_2O_3 and Al disk (top) and Al film (bottom) layers were optimized by rigorous coupled wave analysis (RCWA). Then we experimentally realized the *very high absorption efficiency* (c.a. *98%*), *narrow band* and *tunable aluminum* perfect absorbers.

Figure 1(a) shows the simulated (black) and measured (blue) reflection spectra of a typical Al-MIM perfect absorber. The perfect absorption peak indicating the magnetic mode is located at 7.3 μm while the electric mode is located at around 5.9 μm with small absorption efficiency. Figure 1(b) shows the simulated electromagnetic field distributions in the Al-MIM perfect absorber. Under excitation at 7.3 μm indicating the magnetic mode, the electric field enhancement was found to be 22 while the magnetic field is located in the transparent Al_2O_3 insulator between two Al layers with an enhancement factor of 10. The fabricated Al perfect absorber was used as a selective thermal emitter and showed a promising performance as the thermal emitting surface with narrow emission peak at 7.3 μm as shown in Fig. 1(a) (red). The emission spectra satisfied Kirchhoff's law of thermal radiation at equilibrium.

3. Conclusions

A facile fabrication method to realize a large-area micron-scale perfect absorber with flexible wavelength-tunability in MIR region was developed. These structures showed excellent perfect absorption properties, a can be applied for wavelength–selective infrared photodetectors as well as for thermal emitters [5].

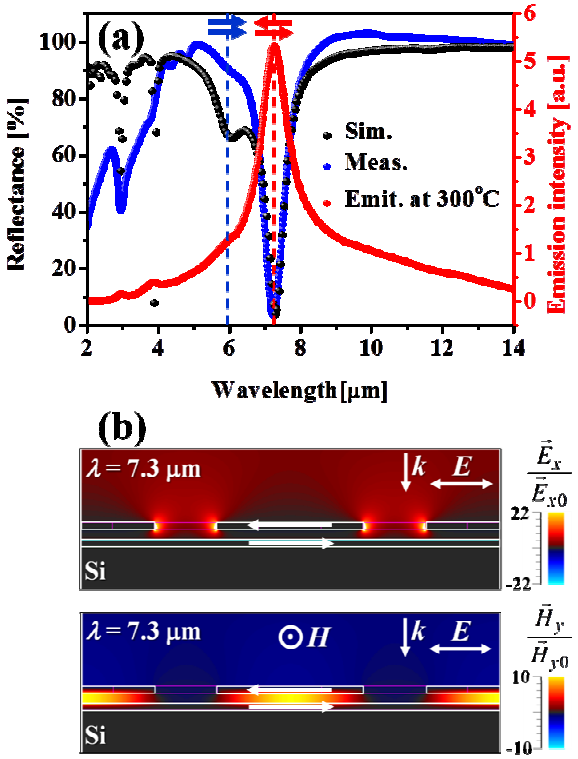

Figure 1. (a) Simulated (black) and measured (blue) reflectance curves of the Al-MIM perfect absorber and measured thermal emission (red). (b) FDTD simulated electromagnetic field distributions in the Al-MIM perfect absorber.

References

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