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Metamaterial absorber for Frequency Selective Thermal Radiation

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Abstract: Here, a polarization-independent frequency-selective thermal emitter (FSTE) in the mid-infrared range was proposed and fabricated based on metamaterial absorber. FSTE can significantly improve the capability of infrared stealth and heat radiation. The simulated results show that the proposed FSTE has high reflectivity in the two atmospheric windows (3.0-5.0μm and 8.0-14.0μm) for normal incidence waves, and the emissivity is suppressed completely under 0.06. In the atmosphere absorption band of 5.5-7.6μm, the FSTE exhibits high absorption and high emissivity, which can passively cool themselves through radiative emission of heat to outer space. E-beam lithography was used to fabricate the FSTE and the infrared emissivity characteristics were analyzed. The experimental results have consistency with the simulation results.

Keywords: thermal radiation, frquency-selective, metamaterial

HIGHLIGHTS:

- A polarization-independent FSTE in the mid-infrared range was investigated.
- The proposed FSTE has high reflectivity in the two atmospheric windows.
- The FSTE can passively cool themselves through thermal radiation in the atmosphere absorption band.
- The infrared emissivity characteristics were analyzed by using the thermal radiation theory.

1. Introduction

Low-emissivity (Low-e) coatings have been extensively studied due to their potential applications on infrared stealthy technologies [1–5]. Low-e coatings are typically deposited on the target in order to reduce the infrared radiation intensity. Therefore the main characteristic feature of low-e coatings is high infrared reflectance. In the past decade, several kinds of low infrared emissivity materials such as core-shell composites, multilayer structures, and nano-composite films have been developed. Noble metals are regarded as suitable active materials for the infrared-reflective coatings. Especially, the resin/metal composite coatings such as resin/Al and resin/Cu composite coatings have received extensive attentions due to their lower infrared emissivity and good mechanical properties for engineering applications[6-7]. However, the Low emissivity in the whole infrared band can reduce the efficiency of heat radiation significantly, leading to rapid rise of temperature especially for targets with high-temperature components. The high temperature of