Paper ID: 41000
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student

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Specialised Technologies, Including Nanotechnology (8)

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EVALUATION OF IR EMITTER WITH PERIODIC ARRAY FOR SPACECRAFT RADIATOR

Abstract

Radiator is a thermal control device which radiates waste heat from spacecraft to space and cools equipment. As an infrared astronomy satellite observes weak infrared signals, it is important to shift thermal radiation wavelength to longer than the observation signals and to reduce irradiation intensity by cooling the equipment. Especially, the next generation infrared astronomy satellite will be cooled at cryogenic temperatures so as to increase the observation performance. However, as a conventional radiator material, such as black paint, shows lower emissivity at cryogenic temperatures, it is not a suitable solution for the infrared astronomy satellite to use it. That is why the new radiator for cryogenic temperatures is required. We focused on a structure consisting of periodic array of metallic elements separated from a ground metal plane by a dielectric spacer layer in order to realize a high emissivity radiator at cryogenic temperatures. When the electromagnetic wave incidents from above to the surface of the radiator, resonance is exited. That is to say, antiparallel current is occurred between periodic array and a ground metal plane, and electromagnetic field in a dielectric layer is enhanced at a resonant wavelength. As a result, the structure shows high absorptance. In other words, the radiator shows high emissivity at the resonant wavelength. The resonant wavelength is determined by material of the radiator, and size and shape of periodic array. In this work, the performance of IR emitter with periodic array will be reported. It was designed by the finite difference time domain method. The periodic structure is a circle with a diameter of 10 μm and the thickness of a dielectric layer is 800 nm. The metal layer is made by Aluminum and the dielectric layer is made by SiO_2. The prototype IR emitter with the resonant wavelength 40 μm was made. Spectral reflectance of the prototype emitter was measured by FT-IR. Moreover, spectral emittance was measured by a black body comparison method, and it was compared with spectral absorptance calculated by spectral reflectance. The peak of spectral emittance was 29.97 μm and that of spectral absorptance was 30.50 μm. Then, the peak of spectral emittance was nearly equal to that of spectral absorptance. In the near future, a resonant wavelength will be changed to longer and a resonant wavelength region will be changed to wider in order to make a radiator with high emissivity at cryogenic temperatures.