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Calculation of radar reflection loss in single-layered case and study on dielectric properties

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Abstract

It is an important issue not only for military purposes but also from commercial point of view, whether or not the reflective wave from an incident electromagnetic wave can be nullified. In this research, by blending conductive carbon black with the binder matrix of glass/epoxy composite, a radar absorbing structure (RAS) which can support loads and absorb the electromagnetic wave has been designed. The RAS was specially designed so as to exhibit the optimum absorptivity for X-band of (8.2–12 GHz) frequency ranges, centered at 10 GHz. An optimized multi-layer design of RAS using the adopted material system is described in this research.

Keywords: reflection loss, dielectric properties, RAS

Introduction

Electromagnetic wave absorbing technology is a valuable topic for military purposes and is also a rising major issue in the business field. Especially, the development of radar absorbing material (RAM), electromagnetic wave absorbing materials in the frequency region of radar, GHz bandwidth, had been actively researched for quite a long time. The basic design theories of RAM, such as Salisbury screen theory, Jaumann absorber theory, etc. were published from early 1950s onwards. But these theoretical studies abated, recently, the main research topic being transferring toward the development of loss material [1]. The role of RAM is reducing the radar signatures of a target by using RAM to cover its surface. A reduction of radar cross section (RCS) can be achieved when there is no limitation of space and weight by increasing the volume of the absorber material and shaping its geometry. Practically, however, the space is so limited that the designer must consider many design factors. In the RAM design, weight, thickness, absorptivity, environmental resistance, mechanical strength, etc. are the main elements that have to be taken primarily into account. Developing the thin RAM which is light and has enough strength to support loads is the main purpose of this research.

In previous research, the development of magnetic absorbing materials using magnetic loss was widely achieved. The research into ferrite based electromagnetic wave absorbers made up the main stream of the research activities of developing RAM [2], and the development of different magnetic loss materials was steadily performed . In high frequency ranges, the weakness of using ferrite materials has compensated for by improving the molecular composition of ferrites and compounding with other materials, but a critical weakness of being heavy still remains [3].

The research of dielectric absorbers using dielectric loss, the methods of combining the particles of carbon black, silver, etc. and using conductive polymer, are widely applied to EMI shielding problems and even for RAM [4]. Dielectric absorbers have a weight advantage but do not match up to the absorptivity of magnetic absorbers. These two loss materials having different advantages and disadvantages of each can be used as a mixture; however, since the magnetic loss material is usually base one, heavy weight of the material is still a concerning problem.

Optimum solutions are suggested under the constraints of the minimization of thickness and the maximization of 10 and 20 dB absorbing frequency