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Design of commercial radar and calculation of surface reflection coefficient

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Abstract

Composite lattice grids reinforced by glass fibers (GFRC) and carbon fibers (CFRC) filled with spongy materials can be designed as lightweight radar absorbing structures (RAS). In the present paper, a computational approach based on periodic moment method (PMM) has been developed to calculate reflection coefficients of radar absorbing composite lattice grids. Two different mechanisms of reflection reduction for radar absorbing lattice grids are revealed. At low frequency, reflection coefficients increase with the volume fraction of the grid cell wall.

At high frequency, several grating lobes propagate away from the doubly periodic plane, and reflection coefficients depend on both the cell wall volume fraction and interelement distance.

Keywords: reflection coefficient, layer spongy foam, specular reflected wave

Introduction

Radar absorbing materials (RAM) are extensively utilized in many fields, especially for military purpose. Conventional RAM such as stealthy coating for aircraft and various shapes of spongy foam absorbers in darkroom have been well developed [1]. However, these materials are either too brittle or flexible to bear load.

Besides, stealthy coatings bring aircrafts undesirable extra weights and expensive maintenance costs. Radar absorbing structures (RAS) have been studied since the end of last century. Design of RAS includes consideration of its load-bearing ability as well as radar absorbing. For structures used in aircraft, lightweight is also an important factor. By blending conductive carbon black or carbon nanotubes with the binder matrix of glass/epoxy composite, solid RAS have been fabricated [2].

This kind of solid RAS is not an efficient load-bearing structure due to its high density. Porous structures such as SiC-foams[3] and polyurethane foams with carbon black or carbon nanotubes [4] have also been studied as RAS. As porous structures, lattice grids are more efficient for loadbearing than foams [5]. Lattice grids are periodic in two orthotropic directions of a plane, with a finite thickness in the third direction. They possess superior mechanical properties, such as high specific stiffness and high specific strength, for which they can be utilized as cores of sandwich structures. The characteristic of high porosity ratio provides it huge potentials in multifunctional design. Recently, composite lattice grids reinforced by glass fibers and carbon fibers filled with radar absorbing lightweight spongy foams were designed as RAS [6]. Measurements of reflection coefficients reveal their outstanding radar absorbing performances.

However, experimental measurements are time-consuming and resource-wasting in design procedure. It is of great value to develop a computational method for reflection coefficient. The characteristic length of the lattice unit cell is usually in the same order as the operating wavelength. Transmission-line theory and transfer matrix method (TMM) based on effective medium