Materials and Design 32 (2011) 3017–3020

Contents lists available at ScienceDirect

Materials and Design

journal homepage: www.elsevier.com/locate/matdes

Short Communication

Electromagnetic wave absorption properties of cement-based composites filled with porous materials

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ARTICLE INFO

Article history:
Received 10 September 2010
Accepted 4 December 2010
Available online 13 December 2010

ABSTRACT

To solve more and more serious electromagnetic radiations, cement-based composites were prepared by introducing porous materials into cement. The reflection losses were studied using arched testing method in the frequency range of 1.7–18 GHz. The results showed that the absorption properties were improved obviously. The mechanisms of wave attenuation of the composites were discussed, which indicated that the scattering and multi-scattering in porous beads played an important role. The filling ratio of porous beads, the bead geometries as well as the conformation of cement all had noticeably influence on the absorption properties. The lowest reflection loss of −22 dB was obtained at 5.6 GHz when the specimen was filled with 50 vol.% expanded polystyrene, and the effective absorption bandwidth (less than −10 dB) reached 10.6 GHz when the specimen was filled with 50 vol.% expanded polystyrene and 2 vol.% carbon black.

1. Introduction

Nowadays, the serious electromagnetic radiations not only influence the normal operation of electronic devices, but also do harm to the health of human beings [1–3]. Thus, the demands for developing electromagnetic wave absorbers with wider absorbing bandwidths and more effective absorption properties are ever increasing [4]. Especially, electromagnetic interference (EMI) preventing for buildings is of increasing importance. Many absorbers [5,6] have been developed to deal with this problem, most of which are cement-based composites.

Cement is slightly conductive and its absorbing ability is poor, but it is a practical way to improve the electromagnetic absorption properties by introducing fillings or loadings. Generally researchers [7–10] develop cement absorbing composites by filling absorbents with large dielectric losses or magnetic losses, including carbon, metal powders, magnetic ferrites and their fibers. Ferrite material has excellent absorption performance in low frequency ranges, and the weakness in high frequency ranges has compensated for by improving the molecular composition of ferrites and compounding with other materials. However, the weakness of being heavy remains still. Dielectric absorbers have a weight advantage but do not match up to the absorption effectiveness of magnetic absorbers. Besides, absorbers which can suppress the reflection from the frontal faces are developed by employing multilayer structures or special shapes [11]. But the complex processes and the decrease of mechanical properties limit their application in cement composites.

Porous materials are complex systems involving elastic structures and air cavities, with good properties such as low density and high specific surface. Thus they are used widely in sound absorbing materials. In recent researches [12], it has been reported that the absorption properties of materials can be improved with porous structures. The main factors influencing on the absorption properties are given such as the pore size, relative density, the sample thickness, and so on. In our study, absorbers with strong absorbing peak and broad-band were prepared by introducing porous materials into cement. The absorption properties and absorption mechanisms of cement composites were described and analyzed, respectively. The effects on the absorbing effectiveness, such as the contents, geometrics of porous beads and the conformation of cement matrix, were also investigated.

2. Experimentation

The porous fillings used in our work were expanded polystyrene (EPS), expanded perlite and porous schist. The cement and water were first mixed in a UJZ-15 mortar mixer with the water–cement ratio of 0.35. Porous beads were gradually added into the paste with the designed volume fraction and mixed to uniform distribution. Then the mixture were poured into the oiled moulds with a size of $200 \times 200 \times 15\ mm^3$ and vibrated on a vibration table for 1 min. The specimen was smoothed with a float and then cured at the room temperature for 28 days.

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doi:10.1016/j.matdes.2010.12.017