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Effects of crystalline phase formation of multiferroic $BiFeO_3$ on microwave absorption characteristics

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Abstract

This paper reports a study of the microwave absorption properties of multiferroic $BiFeO_3$ (BFO) epoxy resin composites. The effects of various sintering temperatures on the crystalline phase of BFO and its microwave absorption characteristics were critically analyzed. BFO nanoparticles were synthesized by mechanical activation high energy ball milling (HEBM) with post heat treatment over various temperatures ranging from 700 to 800 °C. The XRD results showed by using the HEBM method, BFO phase is formed at a lower sintering temperature of 700 °C compared to conventional solid state reaction due to the enhanced diffusion rates. The phase composition and the grain sizes had significant influence on the permeability, permittivity and reflection loss values of BFO composites measured by a network analyzer in the frequency range from 8 to 18 GHz. It was observed that the purity fraction of BFO phase and the grain sizes increased with the sintering temperature. By increasing the sintering temperature up to 775 °C, the microwave absorption properties were enhanced over a broad working frequency range corresponding to the reflection loss below − 10 dB (i.e. 90% absorption) due to crystalline phase changes. BFO samples sintered at 775 °C demonstrated higher absorption ability with RL_{min} − 40.5 dB over a 1.31 GHz bandwidth, showing that $BiFeO_3$ has great potential as a microwave absorbing material.

1 Introduction

In recent years, the spread of electromagnetic (EM) pollution have attracted interest to design microwave absorbing material (MAM) with effective absorption properties in a wide absorption bandwidth. EM interference problems that potentially harmful to biological system and caused misoperation of precise electronic devices can be solved by MAM that used to reduce and suppress the unwanted EM waves. As for applications, an ideal MAM is necessary to have light weight, strong absorption ability in a wideband frequency, thin thickness, tunable absorption frequency and multi functionality [1]. Considerable efforts have been made to design various materials to reach the optimum targets and variety of absorbing materials has been applied to EM wave absorption [2–5]. In order to have good wave absorption performance in a broad frequency range, the impedance matching need to be considered and it could be achieved by the combination of dielectric and magnetic losses in the absorbing materials. There are three possible structures for the purpose to design EM absorbing materials [6]; mixing of dielectric and magnetic materials, multi layer structure and core–shell structure (Fig. 1).

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