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Electromagnetic and microwave absorption properties of Er-Ho-Fe alloys

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Abstract: The $Er_xHo_{2-x}Fe_{17}$ (x=0.0, 0.1, 0.2, 0.3, 0.4) powders were prepared by arc melting and high energy ball milling method. The influence of the Er substitution on phase structure, morphology, saturation magnetization, electromagnetic parameters were investigated by X-ray diffraction (XRD), scanning electron microscopy (SEM), vibrating-sample magnetometry (VSM) and vector network analyzer (VNA), respectively. The results show that the saturation magnetization increases and the average particle size increases with the increase of Er content. The minimum absorption peak frequency shifts towards a lower frequency region with the increase of Er content. The $Er_{0.3}Ho_{1.7}Fe_{17}$ powder can achieve the minimum RL of –24.07 dB at 6.96 GHz with a thickness of 2.0 mm and the minimum RL is less than –20 dB at the thickness range from 2.0 to 3.0 mm. The minimum RL of $Er_{0.3}Ho_{1.7}Fe_{17}$ is –37.26 dB at 5.68 GHz and the frequency bandwidth of R<–10 dB reaches about 1.2 GHz with a thickness of 2.4 mm. And the microwave absorbing properties of the composite with different weight ratios of $Er_{0.3}Ho_{1.7}Fe_{17}$/graphene were researched. The microwave absorbing peaks of the composite shift to lower frequency with the increase of graphene content. The values of the minimum RL of $Er_{0.3}Ho_{1.7}Fe_{17}$/graphene are close to –10 dB with absorbing coating thicknesses increased.

Keywords: $Er_xHo_{2-x}Fe_{17}$ alloys, Reflection loss, Electromagnetic parameters, Magnetic properties, Microwave absorbing properties; Rare earths

1. Introduction

In recent years, with the wide application of wireless communications and electronic devices using the electromagnetic wave in the gigahertz (GHz) range, the appearance of electromagnetic interference (EMI) brings a series of damages to information security and human health[1–4]. Therefore, microwave absorbing materials have attracted much attention because of their extensive usage in many fields to protect against electromagnetic radiation[5]. At present, various types of microwave absorbing materials have been investigated, but they still suffer from various disadvantages.

In current days, excellent microwave absorbing materials are required to have strong absorption, wide absorption band-width, low production cost and high thermal stability[6–9]. These will also be a hot-pursued focus in the research of microwave absorbing materials in future.

The ferromagnetic metal-based materials, iron–cobalt-based alloys attract considerable interest on account of their high permeability, Curie temperature and high saturation magnetizations[10,11]. As a result of the above, the iron-based alloy can become the ideal microwave absorbing materials in the gigahertz (GHz) range. In addition, the interactions between rare earth intermetallic compound with the unique 3d-4f and transition metals contribute to improvement of the magnetic properties because of the change of the magnetic interactions[12, 13]. It will also enhance the microwave absorption properties with wide absorbing bandwidth and optimal matching thickness.

In our previous work[14], it was found that the

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