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The effect of atomic volume on the Curie temperature and exchange integrals in amorphous R–Fe alloys

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Curie temperatures and the dependence of exchange integrals on the atomic volumes in amorphous R–Fe alloys were obtained by means of magnetization measurements under hydrostatic pressure and calculations based on molecular field theory. The hydrostatic pressure leads to decreasing of the ferromagnetic exchange interactions inside the iron magnetic subsystem and to increasing of the antiferromagnetic exchange interactions between iron and the rare-earth subsystems. The results obtained for the amorphous alloys were compared with the results for the crystalline R–Fe compounds.

1. Introduction

The negative exchange interactions between Fe and R subsystems (R = rare earth metals) lead to antiparallel ordering of their average magnetic moments in amorphous R–Fe alloys [1,2], though the local moments may have a non-collinear arrangement. The intermetallic crystalline R–Fe compounds are ferrimagnetics with antiparallel ordering of the R and Fe magnetic moments [3,4]. Ordinarily, three types of exchange interactions are used to describe the magnetic properties of amorphous and crystalline R–Fe alloys: Fe–Fe, R–Fe and R–R. It is possible to assume that these exchange interactions are essentially different in the amorphous alloys and in the crystalline compounds owing to fluctuations of the exchange integrals, distances between the magnetic ions and as a result of the various types of neighbours in the nearest coordination spheres inherent to amorphous alloys. The electron structures in amorphous alloys and crystalline compounds differ from each of the due to the redistribution of the density of the itinerant electron in the disordered atomic structure in amorphous alloys. These effects display at various values of the Curie temperature in the amorphous and crystalline alloys [1].

The purpose of this paper is the determination of the Curie temperatures and exchange integrals dependences on atomic volume for some amorphous R–Fe alloys. These results are discussed in comparison with analogous measurements for crystalline compounds. All calculations were carried out in the molecular field approximation, which was used for description of the ferrimagnetic crystalline R–Fe compounds magnetic properties [5]. It is known that the molecular field theory adequately describes the temperature dependences of spontaneous magnetization in R–Fe amorphous alloys [6–8].

2. Experimental technique

Thick films of amorphous alloys up to 40 μm were prepared by ion sputtering in an Ar-atmosphere [9]. The technique for the magnetization measurements under hydrostatic pressure has been described before [10]. This technique allows

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