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The Thermal and Magnetic Properties of the $Fe_{89.8}Ni_{1.5}Si_{5.2}B_3C_{0.5}$ and $Fe_{81}B_{13}Si_{14}C_2$ Amorphous Alloys

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Abstract:

This paper investigates the thermal and magnetic properties of two iron based amorphous alloys with different Fe-content: $Fe_{89.8}Ni_{1.5}Si_{5.2}B_3C_{0.5}$ and $Fe_{81}B_{13}Si_{14}C_2$. The XRD results show that the thermal induced structural changes occur in the temperature range of 300^0C – 850^0C for the $Fe_{89.8}Ni_{1.5}Si_{5.2}B_3C_{0.5}$ amorphous alloy. The appearance of the first crystallization peaks on DSC thermograms of $Fe_{81}B_{13}Si_4C_2$, amorphous alloy is perceived already at 450^0C. The initial magnetization curves of the as-cast sample of the $Fe_{89.8}Ni_{1.5}Si_{5.2}B_3C_{0.5}$ amorphous alloy, obtained at the frequencies of 50 Hz, 400 Hz and 1000 Hz show the excellent match. The maximum relative magnetic permeability for $Fe_{89.8}Ni_{1.5}Si_{5.2}B_3C_{0.5}$ alloy sample is achieved at magnetic field strength of about 20 A/m for all frequencies, whereas the values of about 7000 were obtained at the frequencies of 50 Hz and 400 Hz. The influence of frequency on total power losses, for both alloys exhibits the increase of core losses with frequency increase. The amorphous alloy $Fe_{89.8}Ni_{1.5}Si_{5.2}B_3C_{0.5}$ toroidal core exhibits about 3 time higher total power losses.

Keywords: *Thermal properties, Magnetic properties, Initial magnetization curve, Hysteresis loops, Total power core losses.*

1. Introduction

Iron based amorphous and nanocrystalline alloys are well established commercial soft-magnetic materials as their properties ratio vs. prices is well acceptable in common electrical devices. There are still intensive research efforts of their sensors effects as a single used ribbon [1, 2] or as a combination of amorphous ribbon with piezofiber [3, 4] or magnetostrictive [5] laminates as a new generation of multifunctional materials. Metglas/PMN-PT fiber laminates as an excellent magnetoelectric composite for low noise sensor of ultralow magnetic field were presented at operating frequency f = 1 Hz [3].

Also, the investigations with two interesting goals are still actually due to reducing size of transformers: the increase of magnetic induction and decrease of coercive force [6, 7], i.e. the improvement of permeability and power losses. The first task was solved with the increasing atomic percentage of the iron content, i.e. with the substantial iron content over 80% that is the most probably position of the eutectic minimum in Fe-M (M-metalloid)

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