Nanocomposites and nanomaterials
The influence of cobalt doping on the thermal stability and magnetic properties of rapidly solidified Fe-B-P-Si-Cu alloys

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Soft magnetic nanocrystalline Fe-B-Si-P-Cu alloys are characterized by high energy saturation induction and low core losses at industrial frequencies. Part of the previously investigated samples are characterized by low core losses but also lower (~1.5 T) saturation induction B_s than other received by us alloys and described in the literature [1]. To increase B_s these alloys were doped by cobalt. This paper investigated its effect on the thermal stability of amorphous ribbons in the initial state and their soft magnetic properties after heat treatment.

A group of alloys $Fe_{81-x}Co_xB_{7.5}P_9Si_{1.5}Cu_1$ (x = 0, 2.5, 5, 10 at.%) have been studied. Amorphous ribbons obtained by melt-spinning technique on a Cu wheel. The best heat treatment for each alloy has been chosen to obtain high soft magnetic properties, which led to their partial or full nanocrystallization. It is shown that thermal stability of ribbons doped with Co passes through a maximum: the base alloy $Fe_{81}B_{7.5}P_9Si_{1.5}Cu_1$ have crystallization onset temperature of 690 K, in other allos - 725, 705 and 699 K at x = 2.5, 5 and 10 at.% Co, respectively. The ribbon with the 2.5 at.% Co is also characterized by the highest total heat of crystallization (145 J/g). Core losses at f=400 Hz and 1 T increases with the increase of Co content from 1.4 to 2.2 W/kg. Saturation induction of ribbon with 2.5 at.% Co has the lowest value - 1.36 T. B_s increases from 1.51 T (x = 0 at.% Co) to 1.57 T (x = 10 at.% Co) for other samples with increasing Co content. Nonlinear dependencies of the properties of the alloy containing 2.5 at.% Co can be explained by lower nanocrystals volume fraction formed under optimal conditions under heat treatment. Measuring the density and structure of the initial state of amorphous and nanocrystalline (after heat treatment) ribbons is the subject to further optimization of soft magnetic properties of Fe-B-Si-P-Cu alloys promising for industrial use.

1. *Zhang Y., Sharma P., Makino A.* Effects of minor precipitation of large size crystals on magnetic properties of Fe-Co-Si-B-P-Cu alloy // J. Alloys and Comp.-2017. -**709**.- P. 663-667.