Nanocomposites and nanomaterials

Investigation of the effect of winding-induced mechanical stresses arising in rapidly heated $Fe_{73}Nb_3Cu_1B_7Si_{16}$ ribbon during core formation on magnetic anisotropy and magnetic properties

A.V. Nosenko, T.M. Mika, O.M. Semyrga, I.K. Yevlash, O.V. Zatsarna, V.K. Nosenko

G.V. Kurdyumov Institute for Metal Physics of NAS of Ukraine, Academician Vernadsky Boulevard 36, Kyiv, Ukraine.
E-mail: Itrij@ukr.net

Today soft magnetic nanocrystalline alloys of FeNbCuBSi system [1] are widely used in magnetic cores of various inductive components (of transformers and chokes). It is known that formation of Fe(Si) nanocrystals in these alloys during heat treatment improves their soft magnetic properties. Volume fraction of nanocrystals in them is 75-80 % and their size is about 10 nm. Hysteresis loop shape can be controlled in these type alloys by inducing uniaxial magnetic anisotropy during annealing under tensile stress [2].

Magnetic cores made of ribbons with induced magnetic anisotropy have a number of advantages, main of them are high field stability of magnetic permeability, low specific core loss in the frequency range of the most widespread use (1-100 kHz) [2] and DC-bias immune [3].

The disadvantage of these cores is the sensitivity of the magnetic properties of the ribbon to mechanical stresses arising during core formation. The purpose of work was to study the influence of mechanical stresses on tensile-induced transverse magnetic anisotropy, the initial magnetic permeability and core loss.

The empirical equation is proposed for calculating energy of induced uniaxial transverse magnetic anisotropy in the core accounting mechanical stresses and tensile stresses applied to the ribbon during its heat treatment.

1. *Herzer G.* Modern soft magnets: Amorphous and nanocrystalline materials // Acta Materialia. 2013;**61**:718-34.
2. *Nosenko A, Mika T, Rudenko O, Yarmoshchuk Y, Nosenko V.* Soft magnetic properties of nanocrystalline $Fe_{73}B_7Si_{16}Nb_3Cu_1$ alloy after rapid heating under tensile stress // Nanoscale Research Letters. 2015;**10**:136.
3. *Nosenko A, Rudenko O, Mika T, Yevlash I, Semyrga O, Nosenko V.* DC-bias immune nanocrystalline magnetic cores made of $Fe_{73}Nb_3Cu_1B_7Si_{16}$ ribbon with induced transverse magnetic anisotropy // Nanoscale Research Letters. 2016;**11**:70.