MODELING THE FREQUENCY DEPENDENCE OF THE MAGNETOIMPEDANCE EFFECT OF AMORPHOUS RIBBONS BY THE FINITE ELEMENT METHOD

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Frequency dependence of the magnetoimpedance effect of amorphous ribbons was studied. Different reasons of the discrepancy in magnitude of theoretically calculated sensitivity and experimental data were considered. A complementary model for variation of magnetic permeability was created.

The impedance of some ferromagnetic materials is observed to be strongly dependent on the applied magnetic field and the driving frequency [1]. This phenomenon has been called the magnetoimpedance effect (MI). It is observed in ferromagnetic materials with well-defined magnetic anisotropy (for example, amorphous ribbons). Transverse uniaxial magnetic anisotropy can be created in Co-based amorphous ribbons due to low negative magnetostriction as a result of stress-annealing. This makes it possible to obtain materials with sensitivity to an external magnetic field reaching hundreds of percent per Oersted. However, the theoretically calculated sensitivity and experimental data have a discrepancy in magnitude, due to different reasons. One of the important parameters is the magnitude of the anisotropy field, which leads to a high MI effect, reflecting a weak magnetic anisotropy [2]. Another parameter that makes the main contribution to the magnitude of the MI effect is the dynamic magnetic permeability. If we consider the impedance from the point of view of classical electrodynamics and use a relatively high value for magnetic permeability, then the frequency dependence of the MI effect will be an increasing power function [3]. Whereas the experimental dependences for Co-based alloys [1] are frequency dependences with a maximum in the frequency range characteristic of the MI effect (1-100 MHz). The purpose of this work was to study the frequency dependence of the magnetoimpedance effect of amorphous ribbons using the finite element method in the Comsol Multiphysics software package.

A complementary model for variation of magnetic permeability was created using Comsol Multiphysics software package based on finite element method. The dependences of magnetic permeability on the frequency of the exciting current and the external magnetic field were found as a solution of the linearized Landau-Lifshitz-Hilbert equation. The sample shape considered to be a rectangular parallelepiped with characteristic values of electrical conductivity 0.295 MS/m and anisotropy field of 5

Oe that varied in small range as well as the value of the frequency of the flowing current (range 0.1 - 100 MHz) and equilibrium magnetization angle. The ribbon had scales of 5×0.2×0.0003 (cm^3). The dispersion angle of effective magnetic anisotropy was equal to 0.1π.

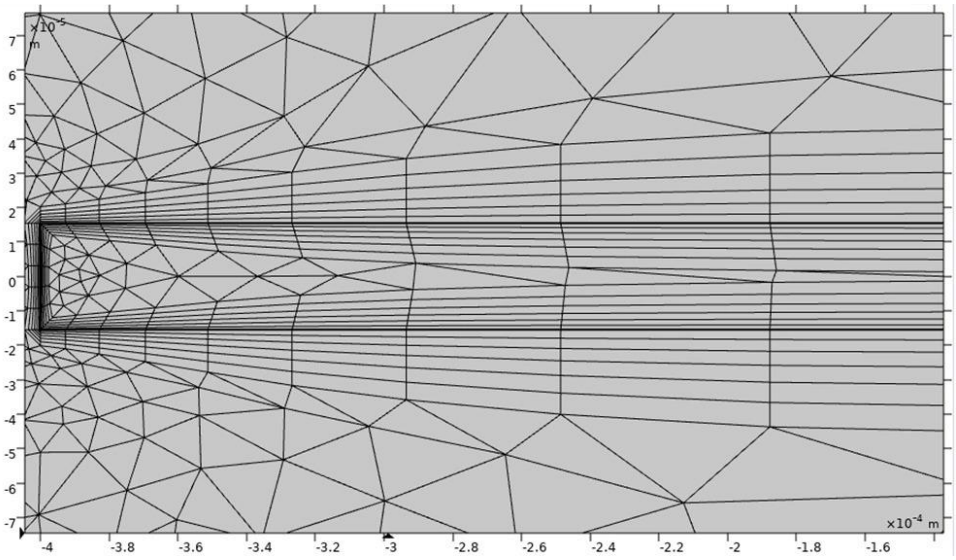

Fig. 1 - The image is an example of meshing for a ribbon, side view

The research was carried out within the state assignment of M.N. Mikheev Institute of Metal Physics of the Ural Branch of the Russian Academy of Sciences of № AAAA-A18-118020290129-5 (theme "Magnet")

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