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EFFECT OF SAMPLE DIMENSION ON THE MAG NETOIMPEDANCE OF CO-FE-SI-B RIBBONS

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Abstract

MI measurements were done on the amorphous $Co_{68}Fe_3Si_{14}B_{15}$ ribbon Variation of the magnetoimpedance with the length has been shown. MI% of 161% was obtained for 7 cm long ribbon while for 5 cm length, MI% of 35% was obtained at 6 MHz and for 2 cm, 35% was obtained at 10 MHz frequency, respectively. MI% decreased with the decreasing length which may be due to the demagnetizing effect. For all the lengths of the ribbon double peak behavour was obtained at high frequency which changed to single peak at low frequency.

Keywords: — Ribbon, Magnetoimpedance, demagnetizing effect

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Introduction

One of the most significant properties of amorphous soft magnetic materials is the magnetoimpedance(MI)[1-2], a property which is useful for materials to be used as magnetic-field detecting sensors. These devices are very sensitive and have a quick response to magnetic field. MI is the change in the impedance of the material in an external steady magnetic field which is applied along the length of the ribbon and is related to the changes in the permeability of the ribbon due to the steady magnetic field.

The MI has been extensively studied in Co and Fe based amorphous or nanocrystalline ribbons [1]. The MI effect is very sensitive to the compositions, sample shape, annealing condition, and stress. In amorphous materials, MI can be optimized by inducing transverse anisotropy by subjecting the materials to thermal or stress treatments. However, few reports are available on the influence of geometrical dimensions on MI.

Experimental details

The alloy was prepared by arc melting the high pure constituent elements in argon

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atmosphere. The ingot was melted several times to obtain a homogenized mixture. The weight loss after the melting was less than 0.5%. The ribbon was prepared by the melt-spinning technique in argon atmosphere. The ribbons obtained were 1-2mm wide and 30-40μm thick. The MI measurements were carried out on 2, 5 and 7 cm long ribbon using an impedance analyzer(HP 4192A) in the frequency range 500kHz- 13 MHz by keeping an alternating current as 10mA in the above frequency range. A magnetic field upto 80Oe was applied using a helmholtz coil. The MI% ratio is defined as $MI\% = \frac{Z(H) - Z(H_{\max})}{Z(H_{\max})} \times 100$, where Z(H) is the impedance at a field H and Z(Hmax) is the impedance at the saturating field.

Results and discussion

Figures1, 2 and 3 shows the field dependence of MI% of the as cast ribbons of 2, 5 and 7 cm lengths, at the different frequency range. For 7 cm long ribbon MI of 161% was obtained at 13MHz frequency while for 5 cm and 2 cm long ribbon, it was only 35% and 34% at 6 MHz and 10 MHz respectively.

At all the frequencies, the MI% values of the 7 cm long are higher than those of the other lengths. The variation of the MI% with length can be explained using demagnetizing field theory [3]. For the short ribbons, the effect of demagnetizing field is larger and thus the complex domain structures are formed at the ends of the ribbon and the domains walls are pinned inside the closure domains because of which the permeability get reduced as compared to the long ribbons[4]. In all the figures, single peak behaviour was obtained at the low frequency which changed to double peak at the high frequency which is due to the change in the switching and the anisotropy field of the sample with the increasing frequency. It is the increase of the switching and the anisotropy field with frequency that in turn causes the double peak behaviour in the MI profile.

Conclusions

Magnetoimpedance variation with the length of the ribbon has been studied for $Co_{68}Fe_3Si_{14}B_{15}$ as-cast ribbon. Ribbon of 7 cm length exhibit larger MI% as compared to the 2- and 5 cm length ribbon.

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Figure captions

Fig.1 Variation of MI% with the magnetic field at different frequency for 7 cm long ribbon

Fig.2 Variation of MI% with the magnetic field at different frequency for 5 cm long ribbon

Fig.3 Variation of MI% with the magnetic field at different frequnency foe 2 cm long ribbon

Fig 1

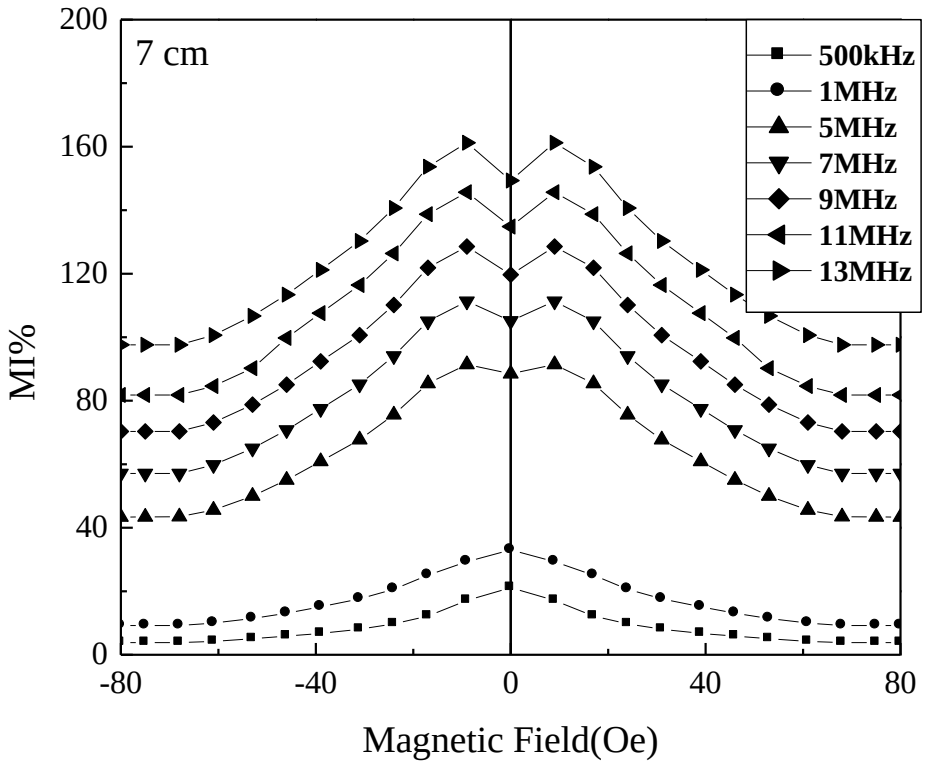

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Fig 2

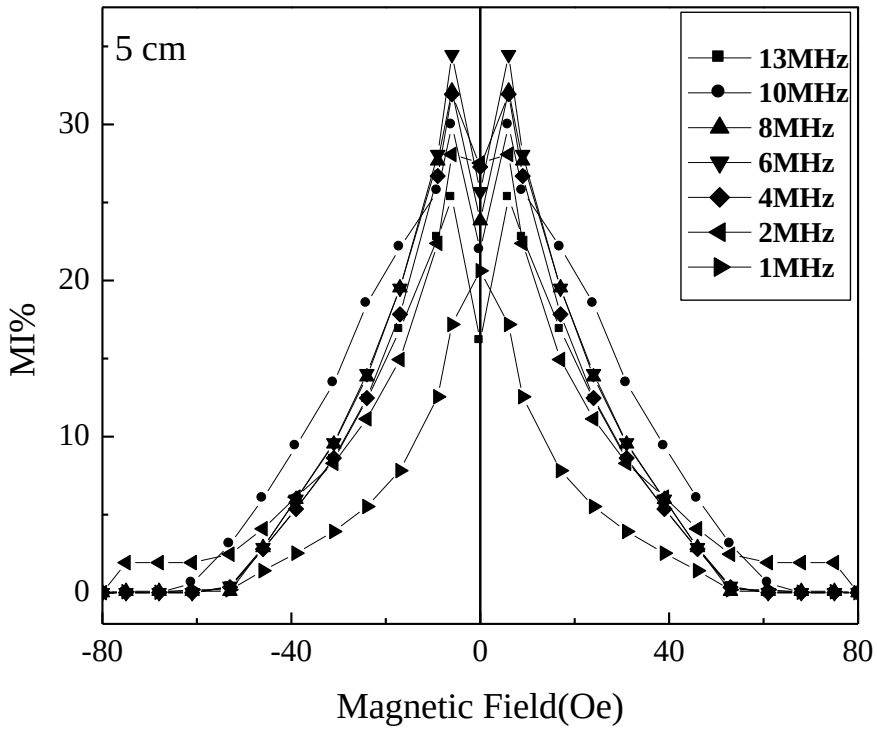

Fig 3