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Electrical and Magnetic Transport properties of Nanocrystalline Alloys.

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Abstract:- In this paper we report the structural, magnetic and electrical transport properties of series of nanocrystaline alloy material which were prepared by the solid state reaction method in air. The X-ray powder diffraction has shown that all our synthesized. samples are single phase and have crystallized in the hexagonal symmetry with R_3C space group. Electrical and magnetic transport properties of $Fe_{73.5}$ $Si_{13.5}$ B_9 Cu_1 Nb_3 (FINEMET) metallic ribbons prepared by standard melt-spinning technique have been investigated through D.C. and A.C. magnetic as well as electrical properties.

It observed that a small self induced AC voltage is superimposed on the D.C. response of the sample. This small AC signal is observed to be periodic in nature and may be attributed to the presence of nonmagnetic metallic spice in the ribbon. The observed electrical and magnetic properties of the material indicate that the alloy in its ribbon form is suitable for its potential use in electrical and magnetic switching devices.

Keyword:- Alloy, Nacrystalline, Transport properties, FINEMENT, Ultreafine grain material, Magnetic phase transition, 1st and 2nd Transition.

Introduction:- Materials with micro structural features of nanometric dimensions are referred to as nanocrystalline materials.[1]

Nanocrystalline metals by definition are of polycrystalline structure with a mean grain size below 100 nm. The Peculiarity of the FINEMET composition[2,3] is that the desired magnetically soft state is supported by a nanocrystalline structures. The material is produced by crystallization of an amorphous Fe Si B alloy with small addition of Cu and Nb, a hitherto some what unusual combination which provided to be a key for the particular ultrafine grain structure and the associated soft magnetic properties.[5] In this paper transport properties of FINEMET type alloy fabricated by rapid quenching technique, such as melt spinning followed by annealing at elevated temperatures to achieve a nanocrystalline structure had been studied. It is sensitive probe to study structure disorders and various scattering processes associated with conduction electron and the disordered and lattices in the solid that occur in a given material and to study the magnetic phase. Transitions[7] Depending on temperatures the electrical resistivity show a series of anomalous especially around temperatures where first or 2nd order transitions takes place.[8]

The frequency range for the best response of the quality factor was also determined trough a comparative study of quality factor and dissipation factor with respect of frequency.

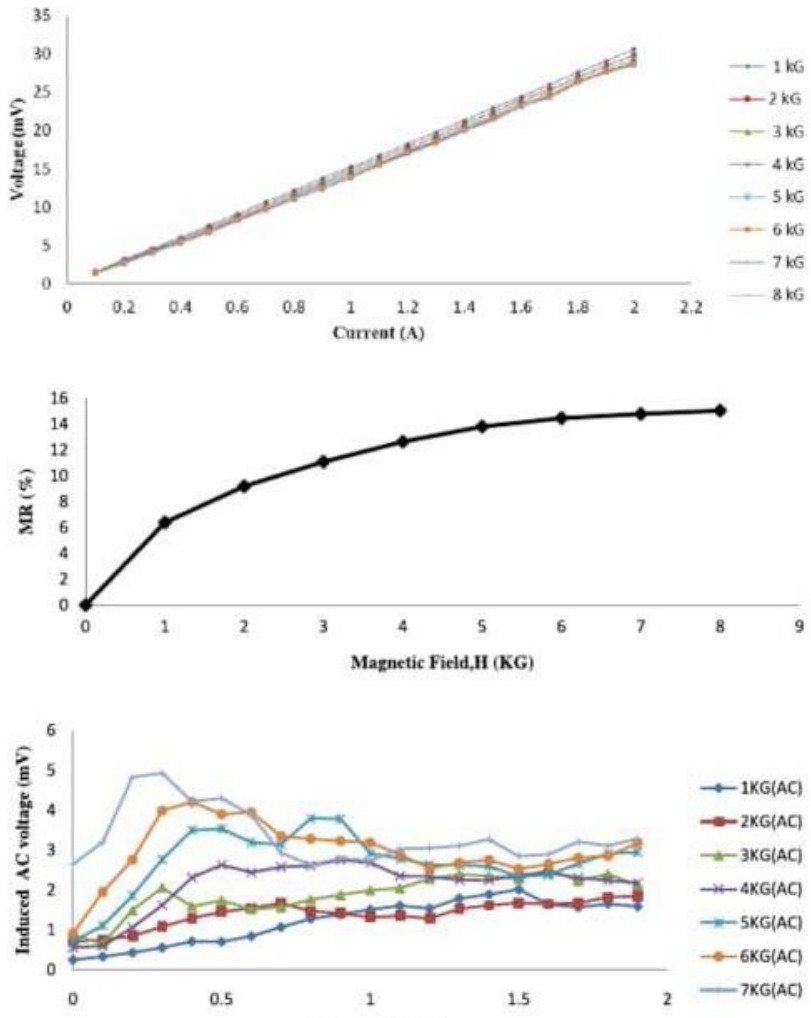
Methodology:- The ribbons were on average 4.2 mm wide and 20μm thick. Ribbons of FINEMET alloys with stoichiometry $Fe_{73.5}$ $si_{13.5}$ B_9 Cu_1 Nb_3 were Fabricated by conventional melt spinning technique. The amorphous structure of the samples was confirmed by x-ray diffraction with cu - k-α radiation. Magneto transport properties of the alloy were determined using a conventional 4 Probe technique. These small eddy ac current is attributed to both the magnetic and nonmagnetic metallic species in the sample.

Result and Discussion:-

Self Induction due to External Transducer.

The sample was placed between the two magnetic cores of the VSM and with the help of transducer it was vibrated with a constant frequency of 37 Hz. The 4 probe technique was used to get the corresponding I (dc) -v (ac) characteristics of different value of magnetic field virgin from 1 to 8 kg.

Graph :-1



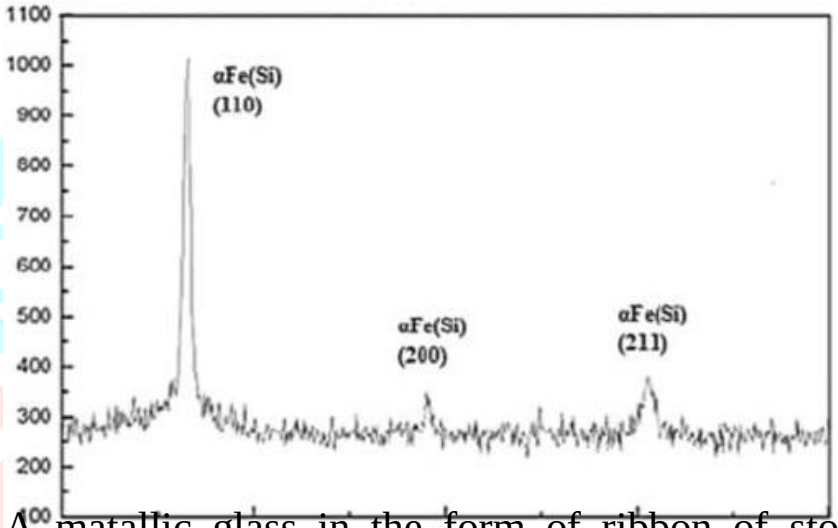
As a sample starts to vibrate with a frequency of 37Hz it cuts the magnetic flux produced by the field as a results on eddy current will be induced in the vibrating sample. For the curves we see that the Oscillating eddy current development in the sample gives rise to an Oscillating voltage which superimposed on the D.C. part often the current reaches a certain threshold value (~ 0.5A) we did not get the oscillating voltage at a lowers current because at low current in the eddy.

Voltage so week that the external D.C. magnet field simply overrides the low eddy voltage.

X-Ray Diffraction Patterns

X-Ray diffraction multi-spun $Fe_{73.5}$ $Si_{13.5}$ B_9 Cu_1 Nb_3 alloy at room temperature taken use Cu- and K - α radiation. A detailed analysis of X-ray diffraction patterns show the predominance of bcc - Fe α-fe Si crystallites with average grain size of 20 ± 5 nm dispersed in the amorphous matrix.

Graph - II



A matallic glass in the form of ribbon of stoichiometric composition $Fe_{73.5}$ $Si_{13.5}$ $B_9Cu_1Nb_3$ (FINEMET) has been studied for its electrical and magnetic properties. The resistivity show monotonous and feeble uptrend until the onset of the glass transition temperature Tg (approximate 480^0C.)

We Conclude that this alloy system will find its applications in magnetic Cores for ground fault in interrupters magnetic shielding common modo chockes high frequency and in electrical and magnetic switching devices.

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