

## Magnetic properties of nanocrystalline $\text{Fe}_{73.5}\text{Cu}_1\text{Nb}_3\text{Si}_{15.5}\text{B}_7$ alloy powder cores with different particle size prepared by rotor mill

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Recently the authors have reported the magnetic properties of Fe-based nanocrystalline powder cores produced by using planetary ball mill[1, 2]. In this study, the relationship between magnetic properties and particle size in nanocrystalline  $\text{Fe}_{73.5}\text{Cu}_1\text{Nb}_3\text{Si}_{15.5}\text{B}_7$  alloy powder cores prepared by rotor mill and cold press was examined.

The melt-spun  $\text{Fe}_{73.5}\text{Cu}_1\text{Nb}_3\text{Si}_{15.5}\text{B}_7$  amorphous ribbons were pulverized by rotor mill(Fritsch Pulverisette-14) and the obtained powders ranging from 10 to 850  $\mu\text{m}$  were classified into several sizes by sieving. Further the powders were annealed in vacuum at 550  $^{\circ}\text{C}$  for 1 h. After nano-crystallization by annealing, all the powders were cooled rapidly in nitrogen gas.

The powder cores were fabricated by cold pressing at a pressure of 15  $\text{ton}/\text{cm}^2$  and adding a glass binder( $\text{SiO}_2\cdot\text{B}_2\text{O}_3\cdot\text{PbO}$ ) of 5 wt% for electrical insulation. The powder cores have inside and outside diameters are 7.2 and 12.6 mm, respectively, and height of about 3.5 mm. Afterwards annealing of these cores was carried out at 400  $^{\circ}\text{C}$  for 1 h in  $\text{N}_2$  gas atmosphere to reduce the press-induced internal stress and to increase the insulation effect by softening the glass binders. The magnetic properties of the annealed powder cores were investigated by using a LCR meter to measure the effective permeability, the quality factor and the dc bias properties, and the B-H analyzer was used for core loss measurement. The micrographs of powder cores were observed by scanning electron microscope.

The powder cores having large particles of 250-850  $\mu\text{m}$  exhibited stable permeability of 100 up to 500 kHz, a maximum level of 50 of quality factor at 50 kHz, and 320  $\text{mW}/\text{cm}^3$  core loss at 50 kHz and 0.1 T induction. However the powder cores with small particles lower than 250  $\mu\text{m}$  showed low permeability and high core loss as compared to large particle cores. Additionally the large particle cores have homogeneous and well aligned microstructure leading to high density state. On the contrary, the powder cores composed of small magnetic particles showed irregular and complex distribution, and the density seems rather low.

The enhanced magnetic properties of powder cores with large particles were considered to be due to the particle size dependence of soft magnetic properties and the compressed state of powders.

### References

- [1] G. H. Kim, T. H. Noh, G. B. Choi, K. Y. Kim, J. Appl. Phys. **93**, 7211 (2003).
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