U-12

Complex Permeability Spectra in Grain Oriented Si Steels With Different Surface Conditions

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1. Introduction

The quality of electrical steels is very important for the modern industry. The improvement of quality of grain oriented Si steels needs very wide information about the steel structure including magnetic domain structure of the steel sheets [1]. Important additional information about magnetic domain structure of Si steel sheets can be obtained from the analysis of modifications in the complex permeability spectra of the investigated samples. Permeability spectroscopy was very useful for the studies of the ac-magnetization processes in amorphous alloys, where the spectra are well decomposed into successive Debye-type relaxations associated with different magnetization mechanisms [2]. However, little information on the permeability spectra in Si steels with different surface conditions has been found in the literature, and no reported results have been found on the modification of permeability spectra after domain-refining surface treatment.

2. Experimentals

The specimens of commercial high-permeability 3% silicon steels were prepared as 30mm width x 300mm length x 0.30 mm thickness. Industrially coated samples were studied after stress relief annealing (SRA) at 800C for 2hrs. Laser scribed samples were treated under the laser beam (pulsed mode) in accordance with different energy regimes. QUANTRONIX Nd-YAG laser (Kr-lamp pumping) has been used, λ=1.064 μm. Frequency spectra of the relative complex permeability, $\mu^* = \mu' - j\mu''$, were measured using an HP4192A impedance analyzer with a 100-turn solenoid coil wound around the rectangular samples. Detail description on the test equipment can be found in previous workers [2, 3].

3. Results and Discussion

The differences of magnetic properties of bare, coated, and laser treated samples are connected with the differences of magnetic domain structures of the materials. Figs.1 (a) and (b) show the real and imaginary parts of permeability spectra, μ' and μ'' at various amplitudes of the ac magnetic field, h_o, in the non-scribed sample. For the low field amplitudes ($h_o \leq 12$ mOe), the spectra exhibit typical Debye-type relaxation dispersions with the relaxation frequency near 15 kHz due to reversible magnetization processes, where the dispersions are independent of h_o.

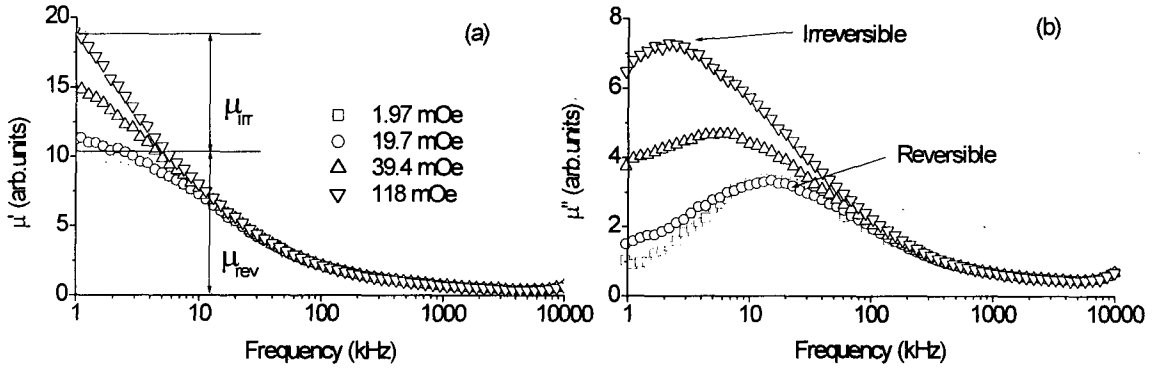

Fig.1. Real (a) and imaginary (b) parts of the permeability spectra, μ' and μ'' at various amplitudes of the ac magnetic field, h_o in the coated specimen.

4. Conclusions

1) It is shown that analysis of modifications in the complex permeability spectra of Si steels having the different surface conditions provide important additional information concerning fine magnetic structure in the materials.
2) Generalized data concerning the modifications in complex permeability spectra for different treated grain oriented Si steels can be used for revealing of optimal technological parameters during laser treatment.

5. References

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