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Effect of Si Contents on Magnetic Properties of the Silicon Steels

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Silicon steels have been widely used for transformer cores. Currently, reducing the iron loss of the silicon steels is one of the most important industrial issues because of high oil price. Up to now, many methods including improvement in {110} <001> Goss alignment, reduction of sheet thickness and refinement of magnetic domain wall spacing have been developed and commercialized to reduce the iron loss.[1,2] For the further reduction, it is inevitable to increase Si contents, which results in the brittleness of the steels and the presence of ordering phases.

In this experiment, high silicon steels were prepared by Si diffusion into commercial 3% grain-oriented silicon steels in order to investigate the effects of second phases on the iron loss. The diffusion process was treated on time control (2, 5, 9, 12 hrs) under 1,200°C in H_2 in a state of sandwiched the silicon steels between Si wafers.[3] The magnetization behaviors and iron loss of the steels were measured by VSM and an H-coil method, respectively. In the H-coil method, the frequency of AC field was 50 Hz (Brockhaus messtechnik, model MPG 100D). The phase analysis of the steels was identified by TEM and XRD.

As shown in Fig. 1 (a), the increase of Si contents results in the decrease of the saturation magnetization. However, the iron loss values are decreased until the 6% Si steel but in the 7% Si steel is considerably increased. According to the diffraction pattern in the 6% Si steel of Fig. 1 (b), the B_2(FeSi) phase is identified from the weak spots and the DO_3(Fe_3Si) ordered phase from weaker reflections. In the 7% Si-Fe, is identified remarkably DO_3 ordered phase more than B_2. These results imply that the ordering phases by Si diffusion decreases magnetic saturation but increases the iron loss. In addition, the ordering phase itself also affects the amount of the iron loss.

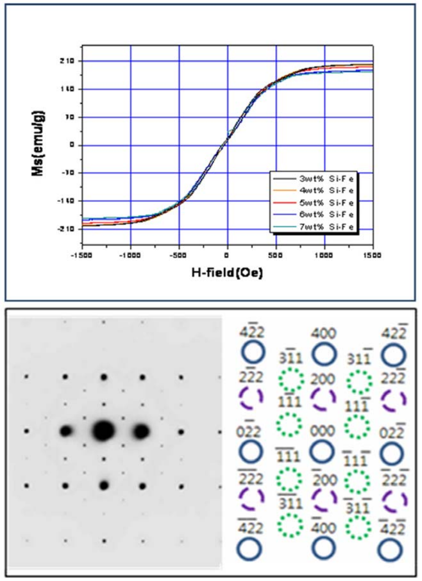

Fig 1. VSM result on Si contents(up, a), SAD pattern in 6% Si-Fe (down, b) is that the solid circle represents A_2(α-Fe), B_2, DO_3, the dashed circle represents B_2 and DO_3, and the dotted circle represents only DO_3.

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Meander Type Inductors on the MgO/Al_2O_3 Thick Films by the Screen Printing Methods

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Systems on Package (SoP) technoques have been actively investigated for the next emerging technologies for the wireless applications [1]. Many researches have been conducted to decrease the number of passive components in the circuit module, which occupied the major part of PCB (printed circuit board). For the SoP applications, it is very important to know and extract the proper parameters of passive components in the microwave ranges.

We will present simulation and characterization of meander type inductor through the structure simulation and electrical measurement, respectively. Meander type inductor was fabricated on the magnesium oxide (MgO) thick film, which is screen printed on the aluminum oxide (Al_2O_3) substrate. The simulation was carried out from 0.1GHz to 10GHz. Simulated and measured frequency dependent inductance and quality factor will be presented, respectively. 3, 5, and 7 turns meander type inductors have been choose to analyze the electrical properties for the RF IC applications. Each size of the meander inductor was composed of 410 μm length, 10 μm width, 20 μm gap, and 10 μm thickness. Ag top electrode patterns were fabricated through the screen printing methods.

Crystalline properties will be characterized by the X-ray diffraction pattern analysis. Lattice parameters of c and a of MgO thick films will be calculated and discussed. To extract frequency dependent inductance and quality factor, proper equivalent circuit models will be presented and its electrical properties will be compared.

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