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Thickness Effect of Magnetic Thin Films on the Conduction Noise Absorption in Microstrip Line

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Several kinds of thin films with high magnetic loss have been proposed to suppress the unnecessary high-frequency electromagnetic noise in highly integrated digital and analogue circuits. Reflection and absorption loss of the magnetic thin films is influenced by many factors including material parameters, frequency, and sample dimensions. Particularly, film thickness gives a strong effect on the propagation behavior of the conducted noise through transmission line, depending on the electrical resistivity of the magnetic thin films. In this study, noise absorbing properties of two kinds of magnetic thin films (one is electrically conductive Co-Zr-O granular thin film and the other is Ni-Zn ferrite thin film with high electrical resistivity) has been analyzed by finite element method (FEM). Using the published electromagnetic data of the magnetic thin films [1, 2], S parameters and power absorption are simulated with variation of film thickness. For Ni-Zn ferrite film with high electrical resistivity (~$2\times10_2$ Ω·m), a low value of reflection loss (S_{11} smaller than -10 dB) is predicted, and the value is not so much different with increase of film thickness as high as 10 μm. However, the transmission coefficient (S_{21}) is reduced with increase of film thickness due to increased power absorption by magnetic loss which is proportional to film thickness. For the Co-Zr-O thin films with low electrical resistivity (~1.6×10^{-5} Ω·m), on the other hand, reflection coefficient is increased with increase of film thickness due to diminished sheet resistance of thin film. For the film of 10 μm thickness, sheet resistance is reduced as low as 1.6 Ω which is much smaller than characteristic impedance of microstrip line (50 Ω). Equivalent transmission line model of parallel circuit of PCB and thin film absorber can explain this behavior of film-thickness dependency of wave reflection. Transmission loss shows a tendency of decrease with increase of film thickness, but not so much sensitive to film thickness for the conductive film. Large power absorption is, therefore, predicted in the film of smaller thickness. It is suggested that film thickness is one of the important control parameters for the achievement of highly absorptive thin film absorbers in the case of high electrical conductivity.

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DU05

Effect of Final Thermal Treatment Conditions on Microstructure and Magnetic Properties of Non-Oriented Electrical Steel Alloyed with Tin

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The effect of different decarburization and grain growth annealing processes on microstructure and magnetic properties was investigated in non-oriented electrical steel sheets. In the study, three steels were compared, a 1.3% Si steel without (0.003%) and with (0.1%) Sn and a 1.3% Si + 0.1% Sn steel that was hot band annealed prior to cold rolling. Samples were secured from commercially processed material cold reduced to a thickness of 0.5 mm. The final heat treatment was applied in a laboratory Continuous Annealing Simulator from Rhesca-Iwatani. Decarburization was conducted over a temperature range of 800 to 900°C in wet HNX gas (dew point about 32°C) to determine the optimum decarburization temperature. The subsequent grain growth anneal was performed in dry (-40°C) HNX gas over a temperature range of 1000 to 1080°C. Electromagnetic properties were measured in the longitudinal and transverse directions on a Single Sheet Tester (SST) at 50 Hz prior to and following aging at 225°C for 24 hours. The hot rolled and final crystallographic textures were characterized via EBSD. Both tin and hot band annealing strengthen the magnetically favorable textures in the final product. IPF maps and ODFs from the final product showed a higher volume fraction of rotated cube texture components {001}<uv0> together with lower fractions of the magnetically poor gamma fiber components {111}<uvw>. In summary, these results show that via control of steel chemistry and processing it is possible to produce electrical steel with a broad spectrum of final electromagnetic properties.