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Development of a Magnetic/Eddy-Current Sensing System For Simultaneous Estimation of Electrical Conductivity and Thickness in Non-Ferrous Metal Plates

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***Abstract*—This paper presents the development of a non-ferrous metal magnetic/eddy current (NFM-M/EC) sensing system for simultaneous estimations of electrical conductivity and thickness for non-ferrous metal plates. For the physical field modeling, the distributed current source (DCS) method models the axisymmetric coordinate magnetic/eddy current fields to design the sensor. Sweep frequency analysis is applied on the excitation coil, and the anisotropic magnetoresistive sensor is used to detect the change in magnetic flux density caused by the induced eddy currents on the test plates. The effects of the frequency mapping method for estimations are numerically validated. Calibration between the model and experimental data by utilizing the mesh refinement method for frequency mapping is introduced to improve the accuracy of estimates efficiently. The solutions of the DCS method employed in the sensor are verified numerically by comparing the results from commercial finite-element analysis software. The proposed design, along with a prototype of the NFM-M/EC sensing system, is used on four different materials with varying thicknesses. The percentage errors of the electrical conductivity and thickness estimations are below 15% substantiate the NFM-M/EC sensing as a new alternative for non-destructive detection.**

***Index Terms*—Eddy current, magnetic sensor, electrical conductivity, thickness**

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