

Double-layered D-shape Eddy Current Coils Embedded in PCB to Quantitative Characterization for Angle of Crack in Metals

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Abstract The defects in metal components can cause serious failures and accidents. Eddy current (EC) nondestructive testing is one of the most effective approaches to quantitatively monitor the defects in metals. However, the quantitative characterization is dependent not only on geometric parameters (e.g. depth and width) but also on the angle information (such as the direction of the crack). Therefore, it is necessary to obtain the angle information to decouple the resultant influence of the crack depth, width and angle on the magnetic flux density. To quantitatively characterize the angle of cracks in metal, a double-layered D-shape coils that are embedded in Print Circuit Board (PCB) are presented in this paper. Then the influence of the number of turns, the distance between the turns, the distance between the layers and the angle of current in two coils of double-layered D-shape coils on the magnetic flux density distribution are analysis by numerical simulation based on Comsol Multiphysics platform; followed that the optimal geometric parameters of the double-layered D-shape coils are determined. Based on the optimal geometric parameters of the double-layered D-shape coils, the relationship of the angles of the cracks and the peak value of the z- component of the magnetic flux density and the time domain signal of the magnetic flux density under the different crack angles are investigated in detail. Furthermore, an approach to quantitatively characterization the angle of the cracks are proposed. Finally, a double-layered D-shape coils are manufactured and an experimental platform is setup. Based on the experimental platform, the proposed approach is verified. This paper proposes a double layered D-shape coils to determine the direction of the crack, which can be jointed the pulsed eddy current technique together to quantitatively monitor the defects in conductive metals. Furthermore, the proposed double-layered D-shape coils are embedded in PCB, so it is easily to design the array eddy current sensor to monitor the angles of the cracks for a large metal component (e.g. the fatigue contact cracks in high-speed rail track). **Keywords:** double-layered D-shape coils; eddy current nondestructive testing; the angle of cracks; magnetic flux density