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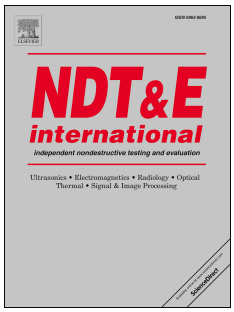

High-frequency Hall coefficient measurement using inductive sensing for nondestructive materials characterization

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High-Frequency Hall Coefficient Measurement Using Inductive Sensing for Nondestructive Materials Characterization

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Abstract The Hall effect is widely exploited in NDE for measuring unknown magnetic fields using a small piece of conducting material of known Hall coefficient. The Hall effect could also be exploited in NDE for measuring the unknown Hall coefficient of conducting materials using an applied magnetic field, but such measurements are fraught with difficulties because of the need to cut the specimen into a small piece similar to a Hall sensor, which of course is inherently destructive. This paper proposes a new technique for nondestructive Hall coefficient measurement based on inductive sensing of the Hall-Corbino current produced by an alternating current injected into the component under test. It is shown that inductive sensing offers numerous advantages over conventional alternating current potential drop techniques. Specifically, sufficiently high inspection frequencies can be used so that the penetration of both the injected primary current and the secondary Hall-Corbino current is limited by the electromagnetic skin depth. Simple analytical approximations are presented to predict the sensitivity of the proposed technique and to calculate the sought Hall coefficient of the material from the voltage induced in the sensing coils. These analytical approximations are first numerically validated by finite element simulations. Then, the results of measurements taken by the proposed new technique on C11000 electrical copper, Al3003 aluminum alloy, and IN718 nickel-base superalloy over a wide frequency range between 10 kHz and 10 MHz are presented to experimentally validate the analytical model. These results demonstrate that the proposed new technique could be used to exploit the recently found favorable stress-dependence of the Hall coefficient on applied stress for near-surface residual stress profiling in surface-treated components made of various metals and their alloys.

Keywords Hall effect; Corbino current; nondestructive evaluation, inductive sensing