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Development of a new magnetic Barkhausen spectroscopy method for the non-destructive characterization of magnetic materials

ORFEAS KYPRIS, IKENNA NLEBEDIM, DAVID JILES, Department of Electrical and Computer Engineering, Iowa State University — Barkhausen emissions, which result from discontinuous, irreversible changes in magnetization, are related to the stress state, defect/inclusion sizes and microstructure of ferromagnetic materials. Time domain analysis of Barkhausen signals measured at the surface of a specimen can reveal the average magnitude of stress in the structure. Such analysis offers a powerful tool for magnetic nondestructive characterization of materials. However, determining the stress and other microstructural parameters as a function of depth still remains a challenging problem, which can be treated in the frequency domain. In this work, a model for stress-depth profiling of ferromagnets is developed. In the model, the frequency spectrum at the surface of a specimen is described in terms of two parameters; the average amplitude of Barkhausen emissions at their origin V_{orig} and ζ, which is proportional to the square root of magnetic permeability. A ferromagnetic structure is mathematically divided into homogeneous layers with each layer acting as a source of Barkhausen signal having a unique spectrum that is attenuated as it propagates to the surface. We show that V_{orig} and ζ correlate with stress and we provide a framework for detecting stress variations as a function of depth.

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