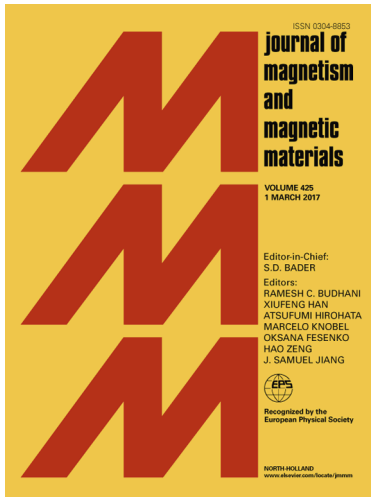

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The effects of the structure characteristics on magnetic Barkhausen noise in commercial steels

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Abstract

This study has been done by separately measuring Magnetic Barkhausen noise (MBN) under different structure characteristics, namely the carbon content, hardness, roughness, and elastic modulus in commercial steels. The results of the experiments shows a strong dependence of MBN parameters (peak height, Root mean square (RMS), and average value) on structure characteristics. These effects, according to this study, can be explained by two kinds of source mechanisms of the MBN, domain wall nucleation and wall propagation. The discovery obtained in this paper can provide basic knowledge to understand the existing surface condition problem of Magnetic Barkhausen noise as a non-destructive evaluation technique and bring MBN into wider application.

Key words: Magnetic Barkhausen noise, carbon content, hardness, surface roughness, elastic modulus, domain wall.

1. Introduction

Magnetic Barkhausen noise (MBN) is generally acknowledged to be a promising nondestructive testing (NDT) method for microstructure tests because of its rapidness, operability, and insusceptibility to the shape and size of the specimen under different environment. When ferromagnetic material is under an alternating magnetic field, the irreversible movement of magnetic domain walls during a cyclic magnetization process produces noise, which can be detected as voltage pulses induced in a search coil. This noise is called the magnetic Barkhausen noise, which is sensitive to various factors that can affect the domain configurations and domain-wall pinning sites, such as fatigue[1, 2], residual stress[3, 4], grain size[5, 6], composition[7, 8], surface condition[9], hardness[8, 10, 11] and the action of external factors such as magnetic field strength[12] and frequency response of pick-up coil[13, 14].

The relationship between MBN and the mechanical properties of the ferromagnetic material has been studied in most literatures, but factors like stress, hardness, and grain size are not the only ones that determine MBN signals. MBN is also sensitive to particular composition of the steel[15], like carbon content, to surface condition and to other organizational structures. Current studies have been done, regarding limitedly on how MBN is affected by these three factors. The study on carbon content mainly includes two parts: 1) the low frequency MBN profile containing two peaks[7, 16], 2) parabolic relationship between the MBN signal and carbon content in plain carbon steel[8, 17, 18]. The research on surface condition is merely limited to the hardness and stress induced by grinding and influence of the surface roughness is only mentioned in articles[19, 20] without further discussion. As MBN can be affected by stress[15, 21, 22] and elastic strain under stress is determined by the elastic modulus E. Apart

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