Modeling Magnetic Barkhausen Noise Generated by the Tetrapole Probe in a Single Easy Axis System

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Magnetic Barkhausen Noise (MBN) is generated by abrupt local changes in magnetization in ferromagnetic materials. These changes are primarily caused by domain wall motion, but may involve other mechanisms. The combination of manufacturing processes, stress, crystallographic texture, grain size and microstructure, affect the steel's magnetic easy axis, that is, the direction of highest magnetic permeability and nominally of highest MBN signal. The easy axis has previously been shown to be identifiable by fitting an analytical equation to angular dependent MBN signals, specifically signals measured with a manually rotated dipole probe.

Until now, no fitting equation existed to characterize the easy axis from angular dependent MBN measured with the tetrapole probe, a probe which substitutes manual rotation with electronically controlled superposition of orthogonal magnetic fields. Because the tetrapole probe, unlike the dipole probe, does not need to be picked up and replaced for angular MBN measurements, experiments are performed more rapidly and with fewer replacement complications. The caveat is that MBN data gathered by the tetrapole probe seldom resembles that of the dipole probe (see Figure 1). The reason, as it is inferred, is that flux superposition on the microscale – about the grain size – works differently in a textured ferromagnetic material than in a homogeneous material (such as air).

This work presents a novel equation for fitting angular dependent MBN data measured with the tetrapole probe. Its development is a significant step towards acquiring the capability to rapidly and accurately determine the magnetic easy axis direction using a tetrapole probe.

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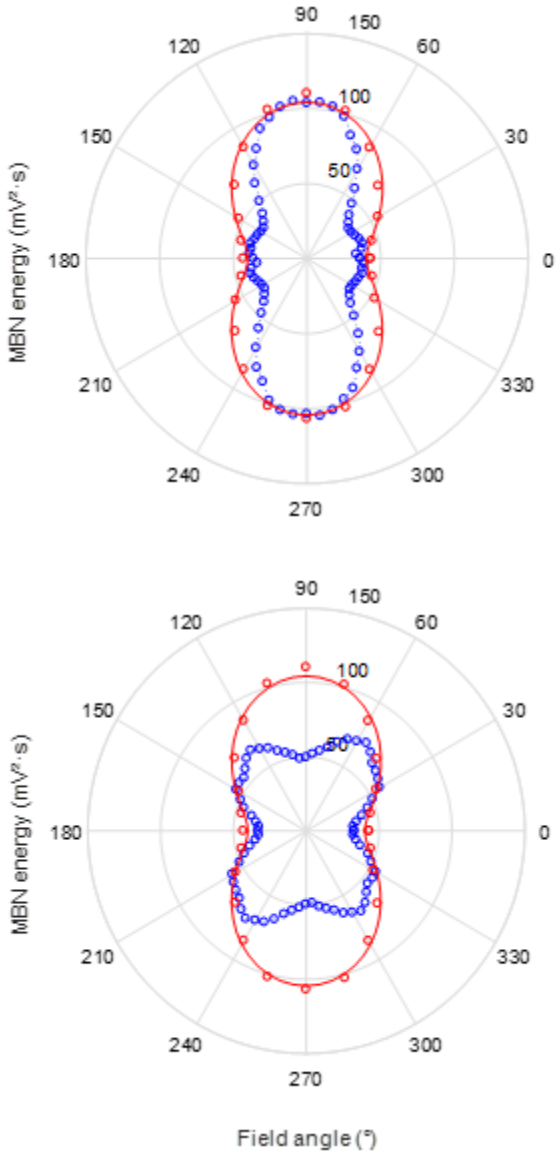

Figure 1. Red fitted dipole data, blue tetrapole data 0° (top) and 45° (bottom) to easy axis (at 90°)