Microstructure characterization of oriented and non-oriented silicon steels in elastic and plastic states based on magnetic Barkhausen noise

Jia Liu[1], Gui Yun Tian[2], Chun Jun Chen[1]

[1]School of Mechanical Engineering, Southwest Jiaotong University, China, [1]School of Automation Engineering, University of Electronic Science and Technology of China, China

As a non-destructive method of stress measurement, magnetic Barkhausen noise (MBN) is a weak random noise signal generated by the discontinuous motion of magnetic domains. The stress in the elastic and plastic range causes the microstructure of the ferromagnetic material to change. The rotation of the magnetic domains under stress produces confusion, which changes MBN signal. Furthermore, the non-uniform evolution of ferromagnetic materials in elastic and plastic states affects the precision of MBN stress measurement. In this paper, a high spatial resolution magnetic head is used to obtain MBN signals in elastic and plastic states to analyze the changes in macroscopic magnetic characteristics of the sample under stress. The changes in grain size, dislocation, and slip under stress are analyzed by using optical microscopy and scanning electron microscope, and the physical relationship between magnetic parameters and microstructure is established. In the plastic deformation process, grain boundary migration and dislocation occur near the grain boundary, which hinder the domain wall movement and make MBN signal show non-uniform change characteristics on the grain boundary and grain. The difference between DW motion and MBN at different positions is greatly affected by the stress. In this study, the microstructure variation of ferromagnetic materials under elastic and plastic stress is characterized, which provided technical support for ferromagnetic materials stress nondestructive testing and evaluation in the industrial field.