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Barkhausen Noise Analysis

The Barkhausen noise analysis (BNA), also known as magnetoelastic or micromagnetic method based on the principle of inductive measurements of a noise-like signal which is generated when the magnetization of a ferromagnetic component. After the German scientist Professor Heinrich Barkhausen, who explained the principle of this phenomenon already in 1919, is called the signal Barkhausen noise.

Barkhausen Noise - the phenomenon

Ferromagnetic materials have small magnetic fields that resemble a model tiny bar magnets and called domains, or Weiss' districts. Each domain is magnetized along a particular crystallographic preferred direction. The domains are from one another by boundaries separated, which are known as domain walls or domain walls. By alternating magnetic fields, the domain walls move back and forth. Thus can move domain wall, the domain must zoom in on one side of the wall, while the domain shrinks to the opposite side. The result is a Modifying the overall magnetization of the part.

When a coil of conductive wire is placed in the vicinity of a ferromagnetic component, while the domain wall moves, produces the resulting Magnetization of an electrical pulse in the coil. For the first time, the electrical considerations of the movement of the domain wall by Professor Heinrich we Barkhausen made in 1919th He has proved that the magnetization process, which is characterized by a hysteresis curve, not really steady and continuously runs, but is made small, sudden steps that occur when the magnetic domains applied under the moving magnetic field. When all electrical pulses generated by all of the domain movements are added, a noise-like signal or which is Barkhausen noise generated.

The Barkhausen noise has a power spectrum, which starts at the frequency and magnetization increases for most materials to about 2 MHz. It is attenuated exponentially as a function of the distance to which it has moved in the material. This is mainly due to the eddy current loss caused, resulting from the propagating electromagnetic fields which are generated by the domain walls. The extent of damping places the Depth determines in which information can be recorded (measuring depth). The main factors affecting this depth are
1, the frequency range of the analyzed Barkhausen noise as well as
2. the conductivity and permeability of the test material.

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The possible measuring depths for practical applications are from 0.01 to 1.5 mm, usually becomes the fringe analysis (grinding burn) only near-surface region evaluated to about 0.05 mm depth.

Barkhausen Noise - the properties

Two important material properties affect mainly the intensity of the Barkhausen noise signal:
One of them is the size of the sign and the distribution of the elastic tensions in the microstructure, which the selected domains and in the preferred direction affect the magnetization closed path. This phenomenon of elastic properties associated with the structure of the domains and the magnetic cooperate properties of the material is called a magneto-elastic interaction. Compressive stresses decrease by the magnetoelastic interaction the intensity of the Barkhausen noise, while the tensile stresses increase the intensity. This applies to materials having positive magnetic anisotropy (iron, most steels, and cobalt, with nickel having a negative magnetic anisotropy, the effect is reversed.) This fact is in the measurement of Intensity of the Barkhausen noise utilized to assess the residual stress state in the edge zone of the material examined. The measure also provides specifies the direction of the principal stresses.

The second material properties which Barkhausen noise significantly affects the microstructure structure. This effect can be approximated on the Microhardness will be described: the intensity of the noise is reduced in the structure with greater microhardness. So give Barkhausen noise measurements Information about the microstructural condition of the examined material.

Barkhausen Noise Analysis - Applications

Many surface treatments such. As grinding, hard turning, hardening and induction hardening, shot blasting cause significant changes in residual stress and microstructure structure of the edge zone which can be characterized by means of Barkhausen noise. The control of hard finishes (test Grinding burn), the main application of the Barkhausen method is processes such as creep and fatigue also change the residual stress and microstructure. and can be analyzed by means of Barkhausen noise.

Practical applications of the magnetoelastic Barkhausen noise method can be broadly divided into three categories:
1. Evaluation of residual stresses; as long as the micro-structure-structural variables remain known and constant.
2. Evaluation of the microstructure; as long as the residual stresses known and remain constant.
3. Check of boundary zones to changes in residual stress and microstructure, which are affected by heat treatments and machining processes can:

*** Non-destructive detection of overheating, control of the grinding process**
* Monitoring of hard turning operations
* Control of heat treatments
* Non-destructive testing of thermal damage of the substrate by passing chromium plating layers
* Evaluation of the surface residual stress in rolling of steel

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