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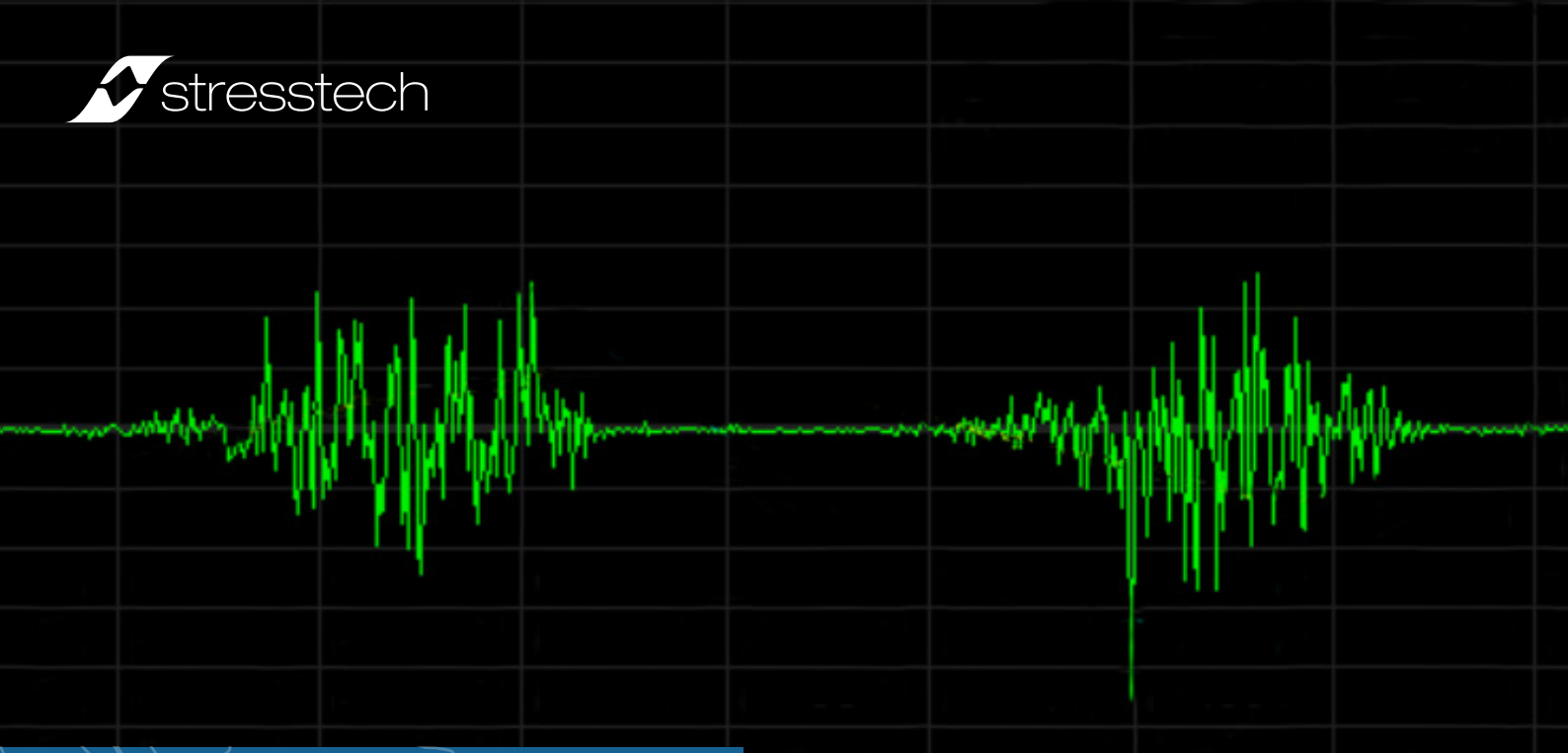


STRESSTECH BULLETIN 1

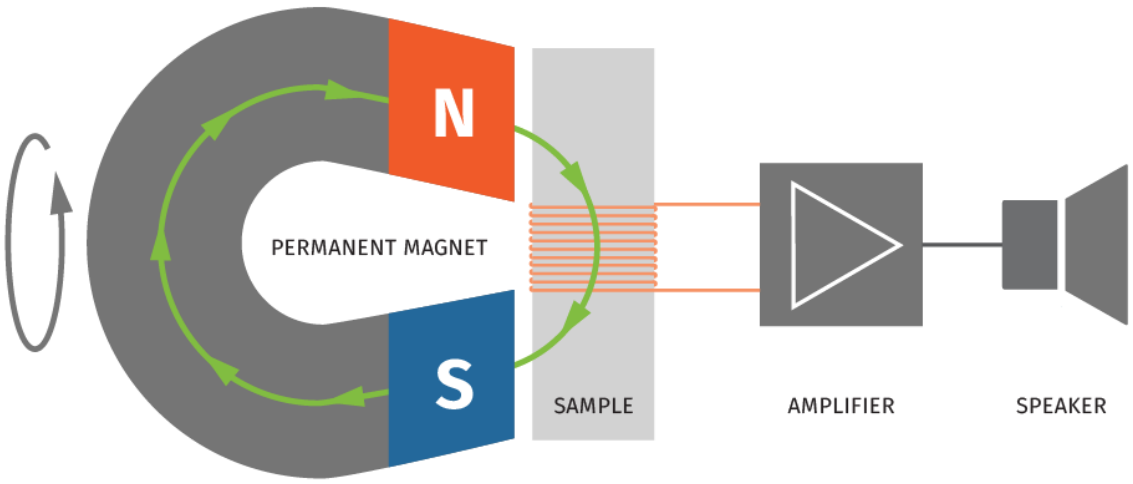
Barkhausen Noise Analysis

Barkhausen Noise Analysis (BNA) is based on a concept of inductive measurement of a noise-like signal, generated when a magnetic field is applied to a ferromagnet.

Text: Murat Deveci, Figures: Stresstech

The nature of Barkhausen noise was explained already in 1919 by Prof. Heinrich Barkhausen. However, the method drew the attention for industrial applications in the beginning of 1980s. Today, it is a recognized non-destructive method for materials characterization and heat treatment defect testing.

To understand the Barkhausen Noise Analysis (BNA), the formation of Barkhausen noise (BN) must be understood well. To create the BN, material must be magnetized hence BNA is applicable only for ferromagnetic materials which are steel (except Austenitic), Nickle and Cobalt and their alloys.



Ferromagnetic materials are composed of magnetic domains in which all magnetic dipoles are aligned in the direction of the easy axis. Domain walls are the borders between the domains. At the domain wall, magnetic dipoles must reorient themselves.

In the absence of a magnetic field (H=0), magnetic domains are randomly oriented. If the material is subjected to a magnetic field, the magnetic domains tend to align themselves in the direction of the magnetic field.

Under the applied magnetic field, domain walls move back and forth because the domain which has an orientation closest to the applied magnetic field, increases its size by expending the other domains which have different orientations than of the applied magnetic field.

When the magnetic field is constantly increasing, all the magnetic domains become parallel to the applied magnetic field by orienting themselves. At this B_S (saturation) point, a polycrystalline material may behave like in a single domain state.

When applied magnetization becomes zero again, some magnetic flux (B) will remain in the material. At this B_r (remanence) point, not all the magnetic domains are able to go back to their initial alignments. Hence, the material has some level of residual magnetism.

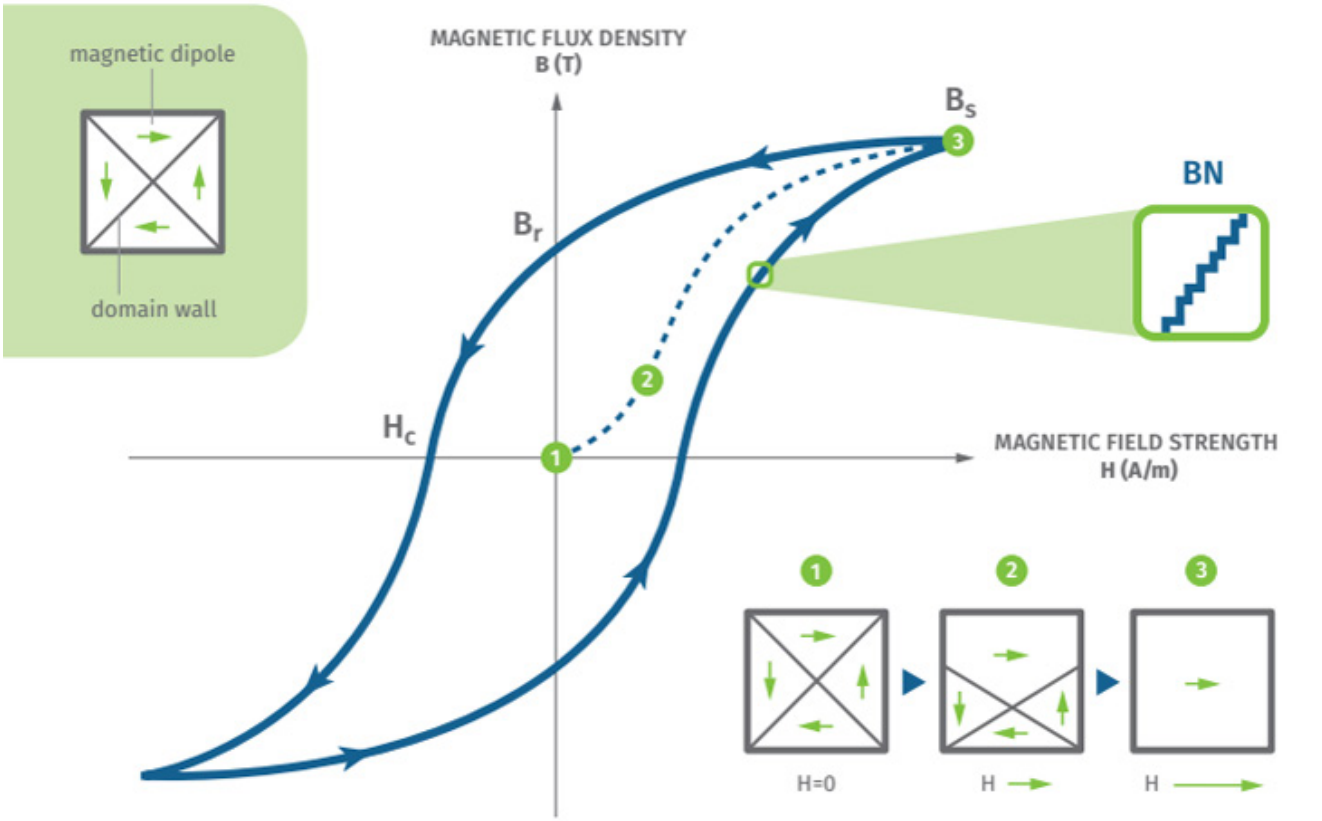
When the applied magnetic field continues to increase in the opposite direction, there is a point, H_c (coercivity) in which most of the domains can go back to their initial alignments. Hence, the material has no residual magnetism.

During their motion, domain walls may spend their energy to consume, the less favorable oriented domains, to move away from the pinning sites. For small external magnetic fields in Rayleigh regime, reversible domain wall movements still may occur. For strong external magnetic field in Barkhausen regime, the energy of the domain walls overcomes the energy of these pinning sites.

This is the reason why domains may not follow the same path to go back to their initial alignments.

Pinning sites which are precipitates, grain boundaries, inclusions, dislocations and small volumes of second phase material, slow down the domain wall's movement. The domain walls may be trapped behind these sites.

The abrupt jumps, due to energy spending to overcome pinning sites, lead to sudden changes in the magnetization of the material.



The changes in the magnetization, induce electrical pulses, which generate a noise-like signal called Barkhausen noise. Barkhausen noise, the irreversible jumps of domain walls, over pinning sites, is called “noise” because of the noise heard from the speaker used in the original experiment.

The intensity of the Barkhausen noise signal is depend on number of Barkhausen jumps (the count rates) which is directly related with the presence of pining sites. In practice, more Barkhausen activity (count rate, jump) leads to a higher signal amplitude.

Stresstech Group is specialized in the industrial applications of Barkhausen noise analysis. Feel free to contact us to learn more about the Barkhausen noise and its applications.

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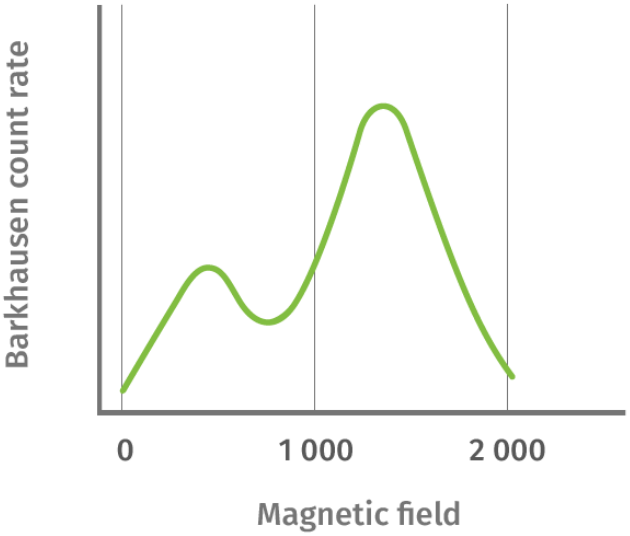

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