Modeling Non-destructive Methods to Gauge Life Expectancy in Ferromagnetic Metals

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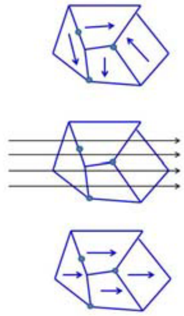
Non-destructive Testing (NDT)

To keep nuclear facilities active and running it is important that we use methods to ensure that reissuing operating licenses run quickly and smoothly. That is what non-destructive testing (NDT) can do. It provides affordability, it does not permanently affect the sample, and it saves time. One such NDT is the Barkhausen Noise Analysis (BNA).

Barkhausen Theory

- Figure 1. Magnetic domain walls in ferrous metals are pinned by fatigue-induced microscopic defects
- Figure 2. Pinned domain walls resist re-orientation due to imposed magnetic field.
- Figure 3. With sufficient magnetizing force, domain walls overcome pinning and the domain spontaneously orients with the magnetizing field, releasing potential energy



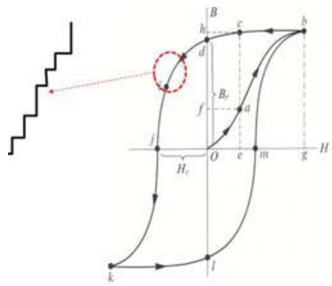


Figure 4. Shows a Hysteresis curve which describes the Barkhausen effect. The curve shows that as the magnetizing field increases so does the magnetic flux density until it reaches a point of saturation. When the magnetizing field is reduced to zero, the magnetic flux density will not return to its original state; the material has become partially magnetized.

Experiment and Tools

Figure 5. shows a steel 410 sample after applied tensile stress. Notice the necking caused in the middle where it broke.

Figure 6. The Rollscan 300, which produces digital signal at multiple frequencies, measures Barkhausen Noise and collects data from each sample using the Microscan 600 software

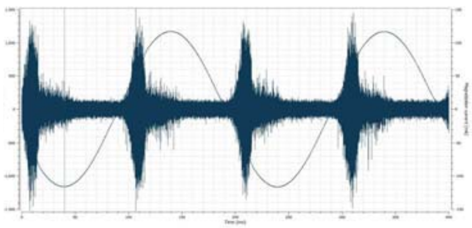


Figure 6. The Barkhausen effect from the Microscan 600.

Figure 7. MATLAB is an interactive numerical computing environment used to develop visual interpretations of data and perform complex calculations.

MATLAB

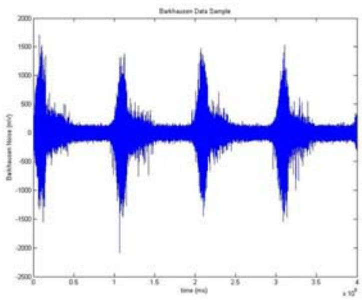


Figure 8. The Barkhausen effect taken by MATLAB.

Goal

- To produce MATLAB scripts to corroborate Microscan 600 data.
- Assist in the data formatting for FORC (first-order reversal curves) using VSM (Vibrating Sample Magnetometer) and IGOR Pro.

Results

- Created a portion of the script that so far corroborates most Microscan 600 data. It will guide the team towards completion in the near future.
- Successfully discovered patterns in formatting FORC files in IGOR Pro and VSM.
- Also learned how to use various pieces of math software, including MATLAB, IGOR Pro, Microscan, VSM, and Mathematica.

Discussion

- Matlab code was developed to model and analyze the Barkhausen signal. After examining the Barkhausen effect we took the results from Matlab and compared them to the results found in the Microscan 600 software developed at American Stress Technologies, Inc.
- FORC data file were formatted to successfully be processed in IGOR Pro and in VSM.

Acknowledgments

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References

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