Heinrich Barkhausen in Berlin and Dresden –

New Applications of His Ideas for Electromagnetic NDE

by

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After studying Physics Barkhausen graduated as Dr. phil. His Ph.D. thesis “The problem of generation of vibrations under especial consideration of fast electric vibrations” was published in 1907 and he immediately received an offer from Siemens Berlin where he worked as Engineer and habilitated in 1910 at the TH Berlin. In 1911 he accepted the world's first professorship in the communications branch of electrical engineering, at the Technical Academy in Dresden (1911) where he worked until his retirement in 1953 with short interruptions. His developments in modern amplifier techniques significantly impacted the electronics technology in Saxony (Germany) and Japan where some of his famous students came from and continued his work. The important effect that caries his name was discovered accidently by applying his new developed amplifiers (Physik. Zeitschrift., XX, 1919. Heinrich Barkhausen „Zwei mit Hilfe der neuen Verstärker entdeckte Erscheinungen.“ - Two new phenomenos dicoverd by using the new amplifiers)

Today Barkhausen noise measurement is an efficient nondestructive technique for materials characterization. Usually the noise is detected by a coil while the magnetic hysteresis of the test material is cycled by an electromagnet. Due to magnetostrictive effects Barkhausen noise is highly sensitive to materials stresses and can be used for quantitative determination of residual stresses and external mechanical loads. The interaction of the magnetic structure (magnetic Bloch walls) with the microstructure of the material results in Barkhausen noise signals that are very sensitive to microstructure variations. Quantification of plastic deformation, of hardness, tensile strength, yield strength, and hardness depth are typical applications.

Other innovative techniques of creating Barkhausen noise by electric current magnetization (Eddy field technique) or using other related effects like Villary Effect, Matteucci Effect *or Procopiu Effect* open new areas of applications for ENDE. When an alternating electric current is used to excite a ferromagnetic wire an electric potential noise can be detected within the electric circuit. This noise can be related to the Barkhausen effect and is sensitive to remagnetization processes. The sensitivity of the effect to residual and applied stresses can be used to develop this technique as a principle for stress sensor technology.

Rotation of the Magnetic fields and autocalibration algorithm overcome the present limitation of the technique. A new auto-calibration method was developed to analyze two-dimensional stresses. A fixed calibration function based on defined parameters (determined experimentally) was applied. To adjust the auto-calibration function to the experimental reference values by varying functional parameters, a large number of measurement points were used. A method that can calculate, based on the multi-dimensional stress state at the measuring point, the stress components σ_{xx} and σ_{yy} for two perpendicular magnetization directions using the Barkhausen Noise effect has been presented.