High throughput material state analysis via Barkhausen Noise-Eddy current microscope

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High throughput methods for development of new materials is getting increasing importance in the field of materials science and is the focus of the DFG Collaborative Research Center CRC 1232 "Farbige Zustände" at the university of Bremen. These methods require large amount of samples to gain statistically founded knowledge about achieved material state and obtain characteristic properties which can represent this material state for its qualification. For production and evaluation of large amount of conditions, small scaled samples are required. For fast analysis of such samples, unconventional measurement methods can be used, but these need to be qualified and correlated to target material properties. Material properties which are of interest are mainly mechanical properties, and microstructure. For this, magnetic non-destructive methods are considered. In this work small scaled steel samples (ca. 1 mm in diameter) were investigated using Barkhausen noise and eddy current microscope (BEMI). The measurements were performed, using high spatial resolution of 20 µm, which is smaller than the sample dimension. The distribution of the values over the prepared samples cross-section measured in 2D-Scan mode using high resolution was analyzed. Multifrequency eddy current analysis showed that there are geometrical and position-dependent influences on the obtained data, even if the penetration depth of the eddy current signal is small and close to the surface. For this study the samples were produced by different methods and underlie different heat treatments. The possibility of the material state qualification and characterization using BEMI are presented and discussed taking into account the sample geometry and measurement strategy. Further, the investigations showed that use of reference measurements of conventional material properties such as residual stresses, phase contents and hardness could be used for non-destructive analysis and prediction of these properties, based on the measurements with the BEMI system.

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