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ROZPRAWA DOKTORSKA

Krzysztof Fryczowski

Ocena stanu tworzywa metodami magnetycznymi

promotor:
dr hab. inż. Maciej Roskosz

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THE EVALUATION OF MATERIAL CONDITION USING MAGNETIC NON-DESTRUCTIVE METHODS

ABSTRACT

The paper presents the issues of material condition evaluation based on measurements of the Barkhausen emission, components of electrical impedance and the components of residual magnetic field. Selected issues related to electromagnetism were described and diagnostic signals and research methods based on them were presented. The main goal of the research was to analyze the possibility of developing diagnostic correlations that would allow to determine the state of stress and deformation, hardness and damage state due to creep proces.

The main goal of the research aim was to develop a methodology allowing the development of correlative relationships for the reverse issues of magnetic non-destructive testing methods. For the measurement, graphic presentation and multivariate analysis of the Barkhausen emission signal data The **BEAT**a (**B**arkhausen **E**mission **A**nalysis **T**oolkit) application was developed.

It was found that among the analyzed parameters describing Barkhausen emission quantitatively, the greatest possibility of developing a diagnostic correlation to assess the engineering stress has the total number of events NoE_{TOT}. Methodology for determining the engineering stress using selected parameters of the quantitative description of the Barkhausen emission has been developed, and the factors influencing the correlation dependences were determined.

The effect of stress on the values of RLC impedance components (in which the test sample was the core of the measuring coil) and on the components of the residua magnetic field RMF was investigated. The obtained results do not allow for the development of a unambiguous correlation.

The analysis of the possibility of plastic strain identification in austenitic steel using components of RMF was conducted. In the case of some grades of steel, plastically deformed areas can be distinguished on the RMF compontents distribution, however, an unambiguous determination of the degree of deformation is possible only above 10% plastic deformation.

As a result of the analysis of the possibility of hardness assessment, it was found that that the change in hardness caused by both strain strengthening and thermo-chemical treatment, the correlations with particularly good values of the determination coefficient were obtained for the total number of events NoE_{TOT} value (in selected ranges of treshold voltage U_g) and for periodograms amplitude A_{FFT} (in selected frequency ranges).

The methodology for determining the diagnostic correlations that could be used in solving the inverse non-destructive testing problems, involving hardness determination based on selected parameters of the Barkhausen emission quantitative description, was developed. Multivariate analysis of the diagnostic signal is possible, which increases the certainty of obtaining the correct hardness value.

It was found that for samples made of steel X12CrMoWVNbN10-1-1 the influence of the creep process is visible in the change of parameters of the Barkhausen emission quantitative description values and magnetic hysteresis parameters values, allowing to distinguish two extreme states of the material (delivery state, state after creep process). The greatest differences between this two states was found for the periodograms amplitude A_{FFT} (greater amplitude was obtained in the case of samples after the creep process). There are also clear differences in the coercivity value H_C between the material in the delivery state and the material after the creep test (the creep process causes a decrease in the coercivity H_C value). Analysis of the possibility to determine the state of advancement of the creeping process requires further research.