Simultaneous Determination of Residual Stress and Hardness for Plastically Deformed Components using Scaled Barkhausen Noise Amplitude

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The determination of residual stress in various regions of industrial components with inhomogeneous microstructure due to different kind of plastic deformation or other material treatment is a rather complex task. In the framework of conventional micro-magnetic methods, it would require solving the calibration of the used micro-magnetic parameters with a huge number of samples with different defined stress states for all relevant microstructural states. From the practical point of view this task seems to be unsolvable since in the most cases such calibration samples will not be available. Therefore a new approach will be presented based on the amplitude of the measured Barkhausen noise signals BHA(H) and the behaviour of that amplitude on the strength of magnetising field H. Taking into account the results of all measuring points with different stress as well as microstructure a scaling transformation of the Barkhausen noise amplitude data is performed, i.e. BHA(H) ◊ X*BHA(Y*H), in order to get a set of rump-up curves with only one unified crossing point at the magnetising field H*. Below that field (H < H*) the scaled amplitude increases proportional to the mechanical stress, but for H > H* the amplitudes have an inverse behaviour. Using an appropriate working point HAP < H* the resulting set of scaled amplitudes will be treated within an autocalibration procedure. For that purpose, physical reasonable calibration functions are suggested. The parameters of those functions are determined by a procedure to minimize the failure for the solution of the inverse problem. The new approach will be demonstrated for bended test samples suffering plastic strain at the near surface layer increasing the external load. For a plate with a welded seam results for residual stress and surface hardness will be presented for the basic material, the heat affected zone and the welded seam using the new approach in comparison with neutron scattering data.