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NDT - Techniques for Life Time Assessment of Components in Service – An International Cooperative Approach

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Abstract

Service induced degradation of material properties is the main limiting factor for the operating life time of components and structures such as pressure vessels and pipelines. Degradation of the mechanical properties of reactor pressure vessel material includes for example a decrease in fracture toughness, an increase in strength and in the fracture appearance transition temperature (FATT). We discuss and verify by SANS-experiments the effects of operating factors on intrinsic material properties (microstructure) that affect properties, which can be measured by NDT techniques. We demonstrate the potential of electromagnetic techniques for characterization mechanical strength that is based on the correlation between dislocations and domain wall movement. The discussed material is the low-alloy, heat resistant WB 36 (15 NiCuMoNb 5). A measurement system was successfully calibrated for the prediction of HV 10 by Barkhausen noise measurement and upper harmonics analysis of the magnetic field. The applicability of this approach was investigated by proving its independence on side-effects like plastic deformation and tensile load. Early fatigue damage and thus remaining lifetime of austenitic stainless steel is correlated to changes of the magnetic permeability and electrical conductivity, which is discussed and described by experiments. For on-line fatigue monitoring of austenitic stainless steel components a GMR sensor technique is proposed and demonstrated. Furthermore, a new thermal NDE method for fatigue damage characterization of Ti 6Al 4V will be presented, which is based on dissipated heat evaluation.