Materials Characterization by Non-Destructive Testing Techniques

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Components and semi-finished products are often tested for quality assurance by non-destructive testing and evaluation (NDT&E) using ultrasonics, X-ray, eddy current, thermal methods, micromagnetic techniques, and other NDT techniques. In ultrasonics, depending on the geometry and nature of the defect, volume, surface and guided waves are employed. For the reception and evaluation of the ultrasound signals reflected by the flaws, synthetic aperture techniques, ALOK, phased array are applied in addition to the standard pulse-echo technique.

This contribution discusses the physical bases of various ndt-techniques, in particular ultrasonics and micromagnetics for different applications such as testing of pipelines, railway wheels, automotive components, components made of high-strength ceramics, and electronic components. Furthermore, methods for the non-destructive characterization of materials, e.g. measurement of the hardening depth in steel and sound-velocity measurements for the determination of mechanical stress, the fatigue and creep state of materials are discussed as well. High-resolution of acoustic microscopy based on atomic force microscopy is presented allowing one to study the elastic and inelastic interaction of ultrasound with the micro- and nanostructure of a material, here nanocrystalline materials and metallic glasses.

A large part of the measurements on which the presentation is based was carried out with colleagues at the Fraunhofer Institute for Non-Destructive Testing (IZFP) in Saarbrücken, Germany, and with many students from the Saarland University, Department of Materials, where the author worked until retirement.

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