By the way, you already know our industrial grade accredited inspection services?

- Accredited laboratory in line with DIN EN ISO / IEC 17025, to qualify and validate new non-destructive testing (NDT) processes for industrial applications
- Accelerated time-to-market and opportunity for qualified, norm-compliant deployment in industrial applications as well as for complete new in-house developments or custom adaptation of innovative NDT technologies, even in fields where norms have not been established
- Certification of the corresponding quality management system in accordance with DIN EN ISO 9001

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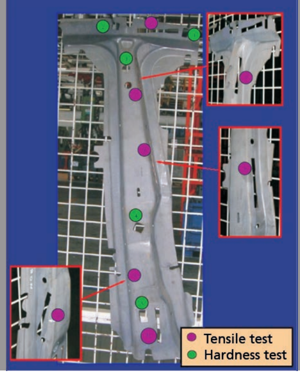
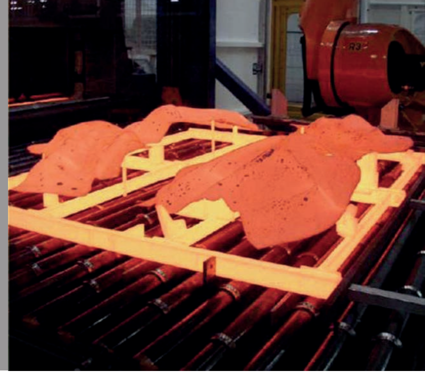
NONDESTRUCTIVE INSPECTION OF PRESS-HARDENED BODY PARTS USING 3MA

3MA inspection of a press-hardened component

Reinforcing components of the car body
Source: Volkswagen



Component with flagged test positions



Heating the circuit boards in a continuous furnace

3MA inspection system with sensor

Situation

Reinforcement elements of the body, such as B-pillars, main chassis beams, tunnel reinforcement etc. are made of high-strength steels, for instance from hardenable boron/steel alloys. This allows to minimize the vehicle weight and with it the fuel consumption while ensuring a maximum of crash-safety of the passenger cabin. To manufacture these components, producers and suppliers in the automotive industry increasingly rely on the so-called press-hardening, as it is particularly resource-friendly and cost-effective compared to conventional forming techniques.

In this process, the plates to be formed are heated in a continuous furnace to approximately 950 °C, i. e. austenitized. By a transfer tool (e. g. a robot) the then glowing red sheets are placed in a press, in which a special, water-cooled tool is installed. While the press is closing, the material is transformed by the tool. Simultaneously, within a few seconds, the plate is deprived of its heat. The rapid cooling results in a martensitic microstructure in the steel, which ensures high strength and hardness of the material.

Solution

To assess the manufacturing quality, the components are randomly tested with regard to their mechanical and technological characteristics. From each production shift an inspection lot, comprising multiple components, is taken. Hereafter, at various positions samples, i. e. tension rods and hardness coupons, are cut from the components, and then tested destructively. To evaluate the production quality hardness (HV10), tensile strength (Rm), yield strength (Rp0.2), breaking strain (A50) and uniform strain (AG) of the samples are determined. These destructive tests are time-consuming and expensive and, thus, are a bar to increasing productivity and efficiency.

The aforementioned destructive methods were substituted by a faster and cost-efficient nondestructive inspection technology. 3MA (Mikromagnetische Multiparameter-, Mikrostruktur- und Spannungsanalyse – micromagnetic multiparameter, microstructure and stress analysis) is a technical and methodical combination of the four micromagnetic inspection methods multi-frequency eddy current, analysis of the upper harmonics, incremental permeability and Barkhausen noise.

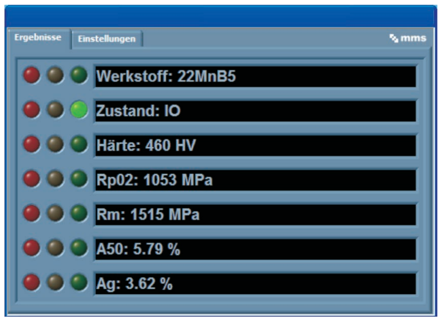
3MA allows to simultaneously determinate various relevant quality features of the materials, e. g. hardness or the variables of the tensile test. For this the probe is manually placed on the component and then the measurement process is triggered. The measurement only lasts some seconds, it is fully automated and can also be integrated into the production process.

Results

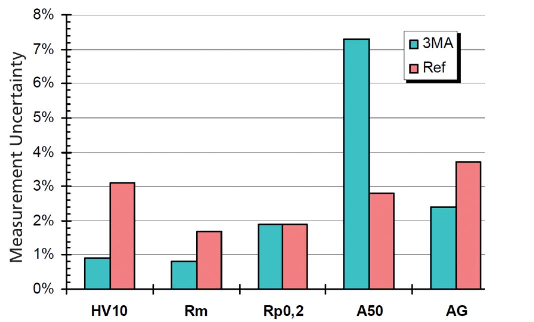
The use of 3MA requires a previous calibration. Based on a multiple regression analysis approximating functions are determined that relate the targeted quality features to the 3MA measures. In the situation of figure 6, the targets are HV10, Rm, Rp0.2, A50 and AG.

To perform the calibration components were taken from the production line and, in addition, special procedure samples were prepared. In this way a set of calibration samples was created which covers the entire range of targeted variables but also the expected variation range of various disturbances (e. g. temperature, thickness, material batch). After calibration the 3MA inspection technique was validated for this special application.

Within the scope of the validation the test constraints were described, limits for the target variables to be observed were set and the extended measuring uncertainty was determined, taking into account all relevant confounders. Identified uncertainties ranged in size of a destructive test and below.



Result of an 3MA inspection



Measuring uncertainties of the 3MA inspection(3MA) and of the destructive inspection by reference technique (Ref)