



3MA Analyzer

Multiparameter Micromagnetic
Microstructure and Stress Analyser
for Nondestructive Evaluation of Re-
sidual Stresses and Microstructures

QNET
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The Situation

Correct heat treatment and machining processes are fundamental for the functional behavior and fatigue strength of stress-imposed components. Until now, the only methods in common practical use to evaluate surface areas of parts and components are conventional techniques such as metallurgy, X-ray diffraction, and conventional hardness testing techniques. However, these techniques cannot easily be integrated into production processes, as their testing speed is too slow and as some of these techniques are also destructive. Nevertheless, the results obtained from these techniques can be used for a statistical process control.

Our Solution

Nondestructive testing techniques, which can be integrated into production processes are available now. A complete inspection with acceptable testing speeds can be achieved. Fast evaluation and recording of relevant quality parameters can be accomplished by combining complementary information obtained through various microstructure and stress sensitive measuring parameters simultaneously. Approximation functions to determine the quality characteristics can be obtained using multiple regression analysis. The main application areas are the nondestructive inspection of case-hardened components and machined surfaces.

The objective is the nondestructive determination of the following material characteristics:

- Hardness
- Residual stress
- Case depth
- Machining defects

Our System

The 3MA system (Multi-Parameter Micro-Magnetic Microstructure and Stress Analyzer) is the adequate instrument for these applications. The 3MA system consists of a PC with monitor, control and evaluation unit, power supply for magnetization, and an analog part with different potential modules to measure various micro-magnetic parameters such as:

- Barkhausen Noise (BN)
Recording of Barkhausen Noise amplitude vs. magnetic field strength (H)
Measuring parameters:
 - M_{max} , maximum of BN
 - H_{cm} , coercivity of BN
 - ΔH_m , width of $M(H)$ envelope at distinct M values.
- Incremental Permeability ($\Delta\mu$)
Recording of Incremental Permeability vs. Tangential (magnetic) Field Strength.
Measuring parameters:
 - $\Delta\mu_{max}$, amplitude of $\Delta\mu$
 - $H_{c\mu}$, coercivity of $\Delta\mu$
 - ΔH_{μ} , width of $\Delta\mu$
- Time signal of Tangential (magnetic) Field Strength ($H_t(t)$)
Recording the time signal of tangential magnetic field strength
Measuring parameters:
 - K, distortion factor*
 - H_{co} , coercivity*

* Both values are obtained through harmonics analysis of $H_t(t)$.

The following example shows the comparison between reference values and the nondestructively measured values using non destructive testing the yield strength-at thin sheets (fig 1).

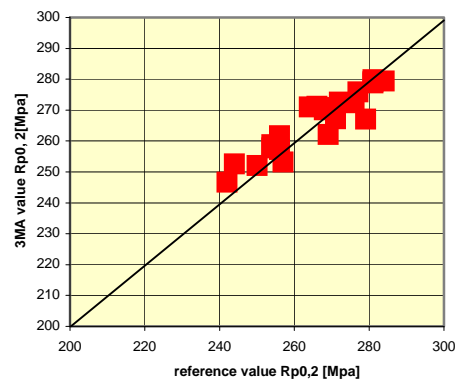


fig1. 3MA-yield strength determination. Comparison of measured and true values

Advantages

- Fast nondestructive testing
- Continuous inspection and documentation of quality parameters
- Replacement of destructive testing
- Economical production through reduced rejections
- Complete process control through integration of the 3MA system into production processes
- Modular design allows for customized configurations and individual adaptation of the user interface software
- Standard data interfaces available

Technical Data

Nondestructive Testing and Evaluation of:

- Hardness
- Case depth of case-hardened components (induction, flame, laser-hardening, etc.)
- Hardness and residual stresses (simultaneously)
- High-resolution residual stresses and microstructures (e.g. welded components)
- Machining processes (e.g. grinding, turning, etc.)

The 3MA Testing system consists of the following components:

- PC with integrated monitor (Windows)
- Magnetization power supply
 - Output power: 300W
 - Distortion factor: < 0.1%
 - Band width: 5 Hz - 120 kHz
 - Amplification: 26 dB
- Sensor System
 - Electromagnetic transmitter-receiver, designed and built according to the requirements of the customer
- Driver Unit
 - Function generator with sine wave
 - Output (frequency range: 1- 250 Hz)
 - Interface to external analog unit
- External Analog Unit
 - A/D converter
 - Signal processing of Tangential (magnetic) Field Strength, Barkhausen Noise, Incremental Permeability and Harmonic analysis
- Software
 - Signal evaluation and documentation on Windows platform
 - Multiple regression analysis to determine process/quality parameters using evaluated approximation functions

Example

The following example shows a 3MA-yield strength determination at moving tape.

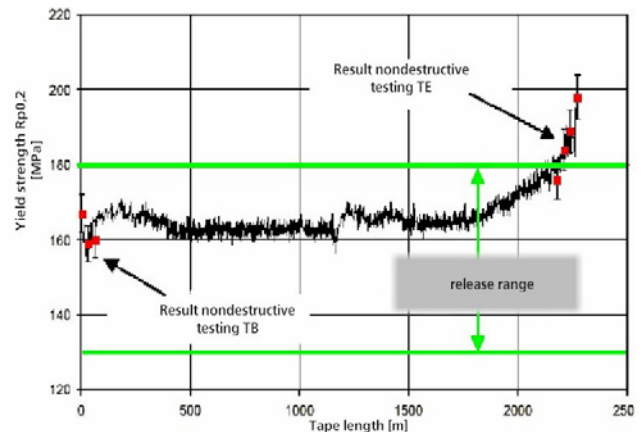


fig.2 3MA- yield strength determination at moving tape.

Sensor System

The sensor is an electromagnetic transmitter-receiver system. The multi-parameter sensor records different micro-magnetic parameters simultaneously. The sensors can be designed and built according to the individual requirements of the customer.

Data Evaluation and Documentation

When the system is working in a production process, the unit can be custom-tailored according to the customer's requirements. The unit can be connected to other commercially available computers for advanced signal processing and evaluation in scientific applications

Our Service

Quality Assurance and Quality Control

- We provide assistance and advice for your QA program and analyse your manufacturing or production process

Support and Inspection Services

- we support you in selecting appropriate inspection methods, technology and equipment suited for your process control
- We inspect your parts and components

Equipment Design, Manufacturing and Sales

- we design and furnish inspection equipment
- Our application center provides worldwide service and repair support

Marketing Services

- We provide support to improve your competitive edge through organizing and execution of national and international research projects
- We support your international marketing efforts.

Our Strength: Q NET partners and FhG cooperation

Our declared objective is to enhance the quality and safety of products and technical services.

Our goal is to improve the economy and competitiveness of your business by reducing the costs due to rejects.

The foundation of our technical competence is the expertise of the Fraunhofer Gesellschaft and the Fraunhofer Institute of Nondestructive Testing, IZFP, made available through joint projects and international partnerships.

Currently Q NET partners are found in:

- United States
- Russia
- China
- and India

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