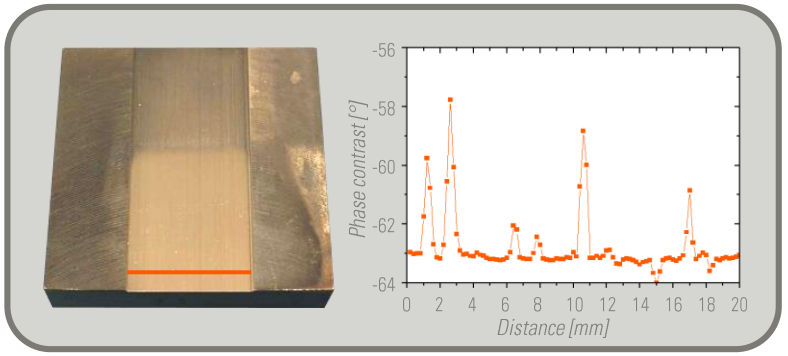
edevis®

Institut
für Lasertechnologien
in der Medizin
und Messtechnik

Characterization of Surface Layers

A large variety of components are carburized, nitrided or coated to increase the mechanical properties of the surface. During or after manufacturing the quality of the surface layer is investigated – in most cases by materialographic analysis. Such tests are very time-consuming and the part must be destroyed. A rapid non-destructive alternative to this technique is photothermics.



Part after grinding and nital etching (on the left), photothermal measurement along the marked line (on the right). Peaks: overheated areas during grinding.

CHARACTERIZATION OF SURFACE LAYERS

Advantages

- *Non-contact*
- *Non-destructive*
- *Faster than materialographic analysis*
- *Inline-testing possible*

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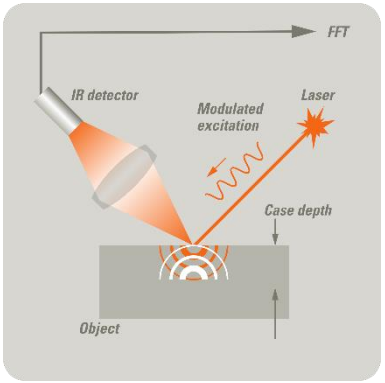
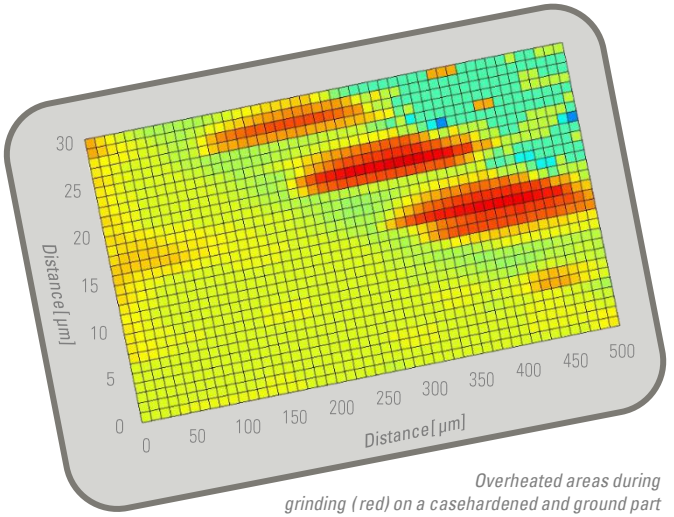
Principle

The photothermal method is based on periodic surface heating by laser light. The modulated heat flows from the surface into the bulk material. This heat flux is influenced by the material properties and geometry of the sample. An infrared detector continuously detects the surface radiation intensity signal which phase and amplitude are analyzed by a lock-in amplifier. Using calibration measurements, the phase signal can be correlated with certain material parameters such as hardness or layer thickness. For this purpose, representative reference samples are required.





Overheated areas during grinding (red) on a casehardened and ground part

Applications

Determination of
- *layer thicknesses*
- *case hardness depths*
- *nitriding depths*

Characterization of
- *hardness profiles*
- *porosity contents*

Detection of
- *overheated areas during grinding*
- *adhesion failure*
- *hidden corrosion*
- *cracks*

Tracking of
- *weld seams*

System

The system includes the excitation laser, the infrared detector, the lock-in amplifier and a PC. The FORAspect software controls the laser, the data acquisition and subsequent evaluation. The measurement is performed optically and therefore in a non-contact way. The system measures pointwise but it is extendable with a scanner. The spot size is adjustable, so that measurements can be performed either within individual grains or in averaging mode along the structure. The classification of case depths at a given excitation frequency takes 10-30 seconds, the reconstruction of hardness gradients 15-40 minutes.

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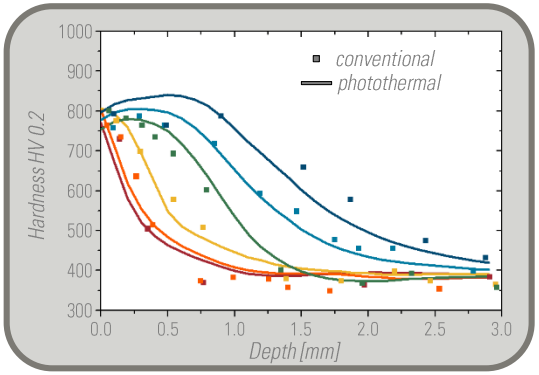
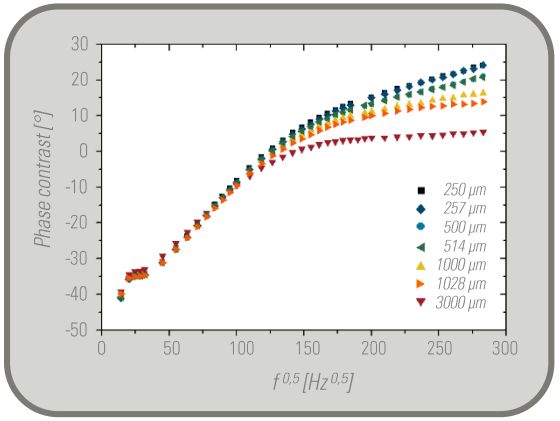
Application

Photothermics is a non-destructive characterization method of mechanically, chemically or thermally treated surface layers including the detection of overheated areas during grinding, hidden corrosion and delamination. After calibration of the phase contrast using a reference body, even quantitative measurements are possible. Thus, not only a good-bad classification of hardened components but also a non-destructive reconstruction of hardness profiles is possible.



Non-contact reconstruction of a hardness profile (after calibration with reference body)



Thickness determination of an Invar layer on a silicon substrate