EVALUATION OF SURFACE QUALITY METALLURGICAL MATERIALS

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Abstract

This paper describes experiments for the development of methods of non-destructive, non-contact surface diagnostics. This is oriented on technical systems in metallurgical operations with usage of laser scanners and digital image processing techniques. There are presented the results of the surface quality evaluation of various metallic materials, in both conditions, cold and hot. The experimental results were used to design diagnostic equipment to support decision-making processes concerning controlling processes in metallurgy.

Keywords: technical diagnostics, material surface, defects, laser sensors, control

1. THE QUALITY OF SURFACE OF MATERIALS

The main precondition of quality of production on metallurgical plants is observance of technological regulations and input raw materials quality and semi-finished products. In the case of continuous casting, attention is also focused on the perfect heat crystallizer work. Defects of casting (i.e. the uneven chemical composition, internal and external cracks, surface defects of type sealed of nests of casting powder, the longitudinal sponge marks of the casting crust, excessive oscillation of oscillation wrinkles, form errors, and others) have their primary causes in crystallizer.

Especially undesirable are cracks in the casting crust of casting caused by ferostatic pressure, temperature tension, rubbing in the crystallizer and other mechanical stresses which can lead to tear of casting of crust and inrush fo. Temperature tension of in the casting crust of the casting is invoked by uneven shrinking during irregular and of intense cooling. [1]

Dangerous is also influence of shape changes of crystallizer caused by thermal and mechanical stress, which has the effect on the reduction of heat removal by reason formation of excessive gap between crust and the wall of the mold.

This process is characterized by various type of input data and their of large numbers. Therefore, it is not practically possible, such a process for use in proceedings, mathematical and physically modeled. This article deals with evaluation of surface quality metallurgical materials with a focus on the diagnosis and visualization of the surface. [6]

2. DIAGNOSTICS OF SURFACE OF METALLURGICAL MATERIALS

2.1. Development of methods for evaluation the quality of the surface

Within the scientific-research activities in the laboratories of the Department of automation and computer engineering in metallurgy, VSB-TU Ostrava being developed a method for verifying the quality of surface metallurgical materials based on laser sensor (distance). Objective being pursued of the solution is to design methods and operating devices providing the information for visualization and evaluation of the surface needed for process control. [2]

Laser sensors, as such, belong to a group of optical sensors. These sensors, optoelectronic, or more accurately termed photoelectric today represent in terms of functional scope, and the associated application possibilities, sensors most used in industrial automation. They are used in safety applications in demanding measurement and control tasks at the end of the process, but also to make great use when monitoring water levels, of the dimension over long distances or when monitoring compliance with content, control of position.

One reason for the increasing interest in the photoelectric are still smaller size and ever increasing efficiency. The advantage is their insensitivity to electromagnetic interferences and noise. The disadvantage is less resistance to humidity, heavy pollution and IR radiation. [3]

Basic of properties of elements used is the conversion of electric current to the electromagnetic waves - light and vice versa. The term light shall mean electromagnetic spectrum from ultraviolet region (λ = 0.3 μm) over the visible light region (0.38 <λ <0.78 μm) up to the infrared range (λ = 1.2 μm).

At the beginning of the use of optical sensors were as transmitting elements mostly used light bulbs and as elements of receiver are used photocells or photoresistors. Due to the wide range of unfavorable properties of these elements were application possibilities of these sensors very limited. [3]

2.2. The diagnostic device

The foundation of diagnostic device is a laser sensor optoNCDT 1302/200 working on the basis of triangulation measurement, which is connected to the PC via PCI measuring card NI 6221.

Laser sensor OptoNCDT 1302/200

Sensor (**Fig. 1**) from Micro Epsilon with a measuring range of 200 mm was chosen for laboratory testing and verification of the proposed method, achieves an accuracy of 500 μm with sampling of 750 Hz.

Technical specification:

The beginning of the measuring range [mm]	60
Middle Range [mm]	160
The end of the measuring range [mm	] 260
Linearity [μm]	500
The resolution static noise	40
Dynamic resolution of 750 Hz [μm]	100

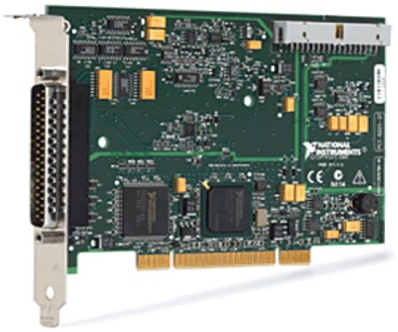
Fig. 1 Laser sensor OptoNCDT 1302/200

Diagnostic measurements using the measuring card NI PCI 6221

Measuring card (**Fig. 2**) from National Instruments PCI slot is relatively efficient device for sensing or measuring of analog or digital electrical signals, as well as for generating such signals. [3] At the software level, the card is able to cooperate with the operating system Windows and with environments Matlab and LabView.

For diagnostic measurement was assembled computer with the following parameters:

- Motherboard with PCI slot;
- Processor AMD Sempron 2800 + 1.60 GHz;
- 1GB of RAM;
- Memory disk with a capacity of 20 GB;
- Windows XP SP2.



Technical specifications of memory cards:

-16 - Bit, 250 ks / s, 16 analog inputs with 37 - pin D-Sub;
Two 16 - bit analog outputs (833ks / s);
10 digital I / O lines, 32 - bit counters, digital triggering;
Correlated DIO (2 lines, 1 MHz);
37 - pin D - Sub connector;
Controllers NI - DAQmx driver and software NI LabVIEW SignalExpress;

Fig. 2 The measuring card NI PCI 6221 (37 – pin).

In order that we could scan the surface of the material using a PCI card NI 6221, we must had correctly set the program Matlab and thereafter measuring was performed in MATLAB.

It was further necessary to select parameters: measuring mode between synchronous and asynchronous, type measuring card or other equipment installed, setting the number of samples scanned per second, setting the block size of input type, selecting the measurement channel and adjustable output from the block. For measurement was selected following settings with the following parameters: asynchronous signal at a frequency scanning 10,000 samples per second from a connected channel AI8, 0.08 seconds measuring time as a normal type of measurement. These parameters have been set in the window Simulink.

Measurements, which were performed, you can view in block Scope. The file with the time course of values were inserted into a block simout, that displays a graphical course of measurement.

2.3. Testing of components diagnostic system

Within the of solution this issue was created several of laboratory of prototypes solutions. In **Fig. 3** and **Fig. 4** prototype solutions using robotic hand.

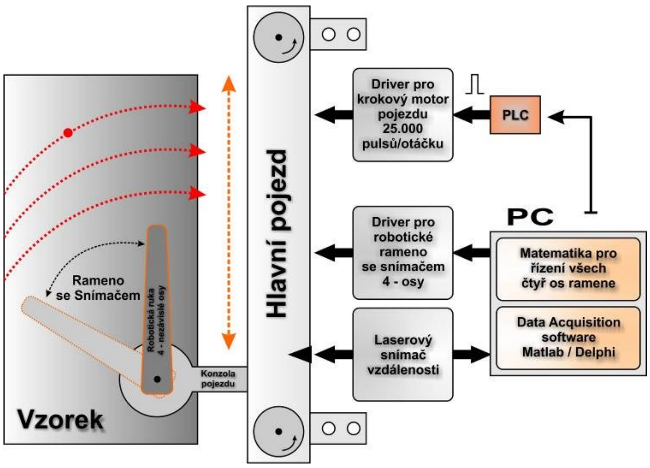


Fig. 3 The principle of scanning the surface of the mold using a robotic arm with a laser sensor.

It is the robotic automated diagnostic system, whose main components are linear travel of, a robotic arm, a laser sensor, control unit and the the evaluation PC.

Fig. 4 View of the measuring assembly for verification of the surface - the wear surface metallurgical materials (measurements in laboratory conditions VSB - Technical University of Ostrava)

The system allows monitoring of the surface of metallurgical materials and creating a of a computer image in 2D and in 3D embodiments. Example results [4] from laboratory experiments are shown in **Fig. 5**.

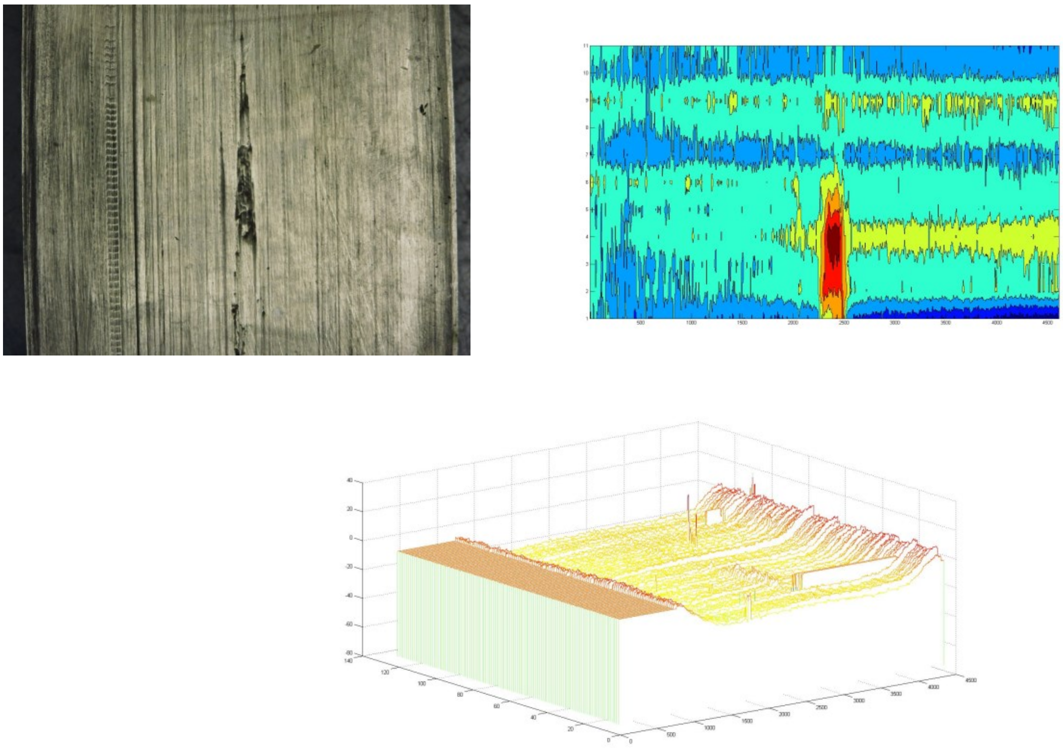


Fig. 5 Demonstration of results visualization surface metallurgical materials (original surface, 2D visualization with filter, 3D visualization)

Laser scanners

The next stage of laboratory research was to testing of "blue" and of "red" of laser scanner. With these special sensors experiments were performed to verify the possibility of the fundamental components of diagnostic system. Were scanned surfaces of metallic materials under different conditions. In **Fig. 6** are examples of attempts and example of the results in graphic form.

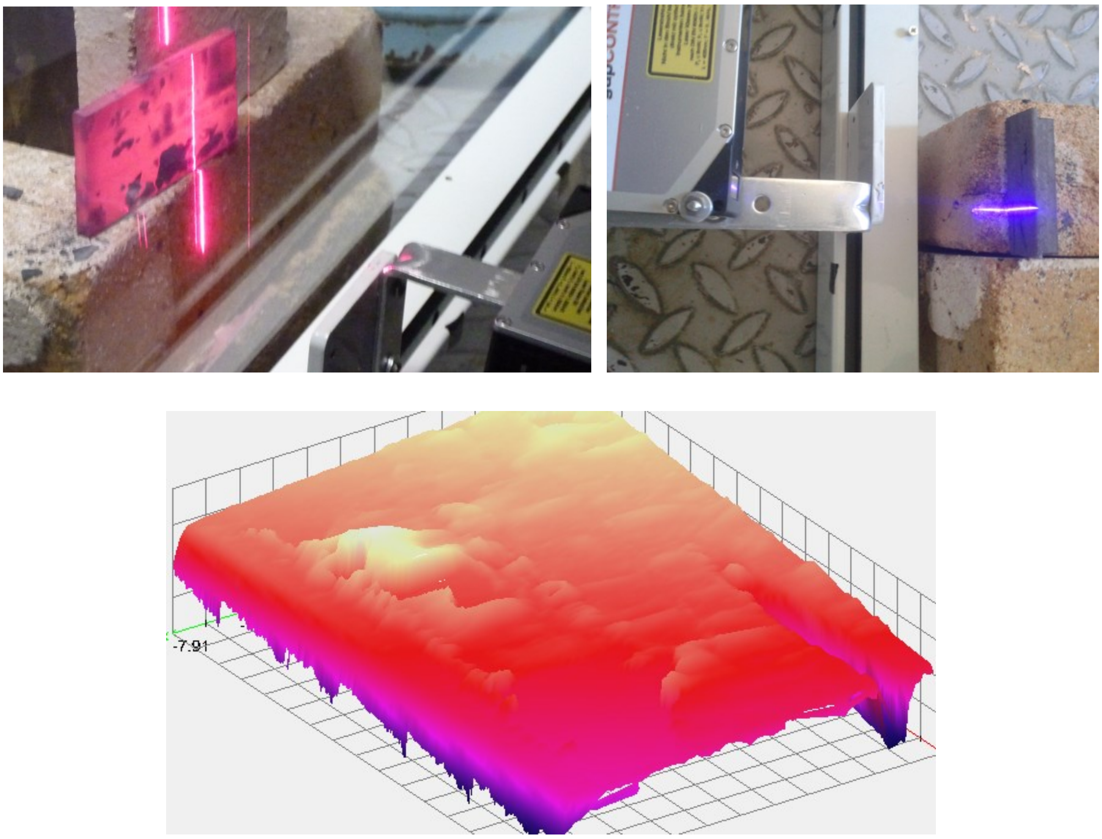


Fig. 6 Examples of attempts with laser scanners (red, blue) and example of the results in graphic form

CONCLUSION

The quality of production and safety of production in terms of the emergence of surface defects related both by technologies, but also with the overall state of the device. Both aspects are still the subject of frequent the development and improvement. The complexity of metallurgical processes almost does not permit generalization and transferability of results from device to device. On different technologies are completely different conditions in the production of different sizes or different steel grades. Therefore, the diagnostic of the surface of materials still has an important role in controlling these processes. In the context of research activities is issue solving in the long term. [5]

In solving are applied to modern diagnostic equipment - at present lasers and laser scanners and modern tools for evaluating the results of diagnostics - methods of artificial intelligence [4], machine learning. The achieved results of laboratory tests show the correctness of the approach to solving and new possibilities in technical diagnostics of surface of materials.

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