IDENTIFICATION AND EVALUATION OF MACHINING PRODUCT DEFECTS IN TEACHING OF STUDENTS AT COLLEGE

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Abstract. In the education of students in technical fields a very important aspect is their meeting with the solution of practical problems and with practical examples. No matter what the namely discipline is, but practical demonstrations in technical education must be an integral part of teaching. At the FPTM the study program "Materials and Technologies in Transport" exists and as it is already evident from the name, the teaching in the field of materials and technologies is the main content of this field. And in this teaching it is also necessary to introduce students to the principles of identification of defects and possibilities to correct them. These principles are illustrated with examples of specific cases; there are suggested resources and procedures that may be used for identification. Such demonstration brings this contribution. The article approaches and provides opportunities to learn in this field in college.

Keywords: teaching, student, identification, defect, material, technology.

Introduction

Teaching of technical subjects has some specifics and its integral part is also presentation of the practical solution of the given problem. In the education frame of students on the field of material engineering it is necessary to acquire knowledge on the ways of identifying defects on the products that arise during production.

Students must be familiar with the ways and possibilities of identification of these defects because the defects on the products (cracks, stains, etc.) do not harm the visual character of a product only but often have a significant impact on its functionality [1].

Defects on workpieces often occur after semi-processing, but this is not necessarily the technology itself, during which the defect occurred, but also the earlier steps, such as the production of the material, its quality, the method of processing to form a blank, surface pretreatment, etc. Often it turns out that at some stage of production the technological discipline has not been respected or the material does not contain the declared components. And familiarity with these aspects for the students, who will work in the future as technologists or material engineers, is very important [2-4].

Defect identification

First, the students must be familiar with the fact that the identification of defects must follow some procedure and implement the necessary steps. It is important also to familiarize the students with the equipment that can help identify and describe the defects [5-7].

The basic steps in identifying defects are thus:

1. To locate and determine the exact location of defects, including samples collection,
2. To take pictures of the product, the stock and defect location,
3. To determine the cause of defects theoretically,
4. If necessary, to carry out the spectrographic analysis of the processed material,
5. To investigate the microstructure and macrostructure,
6. If necessary, to carry out the chemical microanalysis by an electron scanning microscope (identification of inclusions particulate phase, coatings, dirt, etc.),
7. To make further technological tests, such as detection of mechanical properties, hardness, etc.,
8. Base on theoretical knowledge, knowledge of technological processes and acquired knowledge,
9. From analyses to determine the location and cause of the defects.

Defect identification with the place specifying and their causes is the component of constant improvement of technological processes. [4; 6; 7]

Fig. 1 shows an example of a part, which is presented as an example for students. This part was made from A molded blank and then a thread was machined on it. After machining the crack appeared on the component. This crack can also be seen by looking at the bottom surface of the flange (Fig. 2), these images are examples of basic documentation, which must be done for defect identifying.

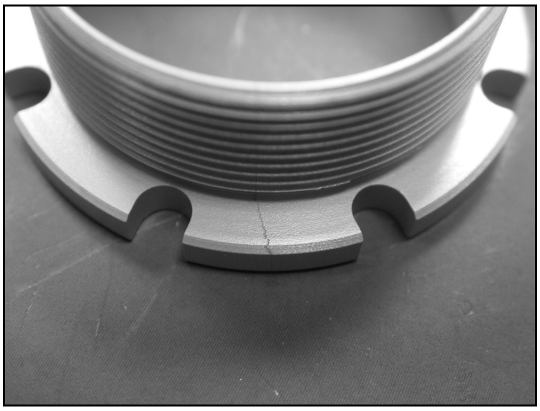

Fig. 1. **Product with crack**

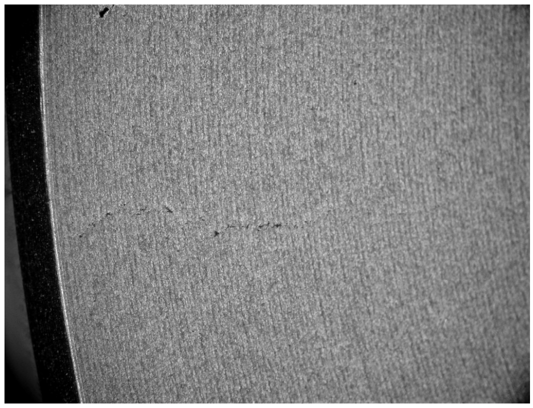

Fig. 2. **Crack at the bottom of flange – macro**

An important step is defect identification and its inclusion and classification, when the important tools are standards (eg, ČSN 42 1240) or company classification, when the enterprises themselves, based on their production orientation, usually compile a codebook for quantification and identification of defects and their admissibility. It is also necessary to introduce the student in the lessons with these materials [2; 5].

Fig. 3 shows the ready microstructure in the defect area which was obtained by part cross-cut. Fig.4 shows the cut of a crack in the longitudinal direction. These pictures are an example of further processing of the samples as they are presented to the students.

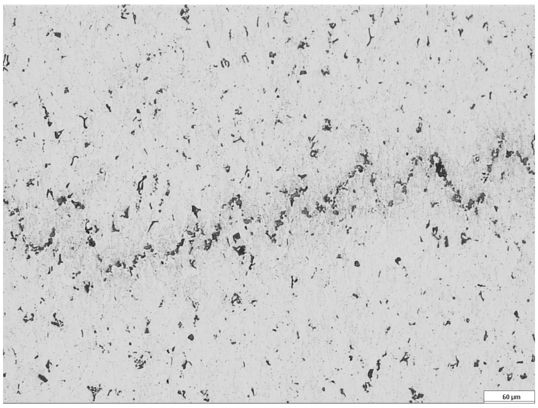

Fig. 3. **Microstructure – cross section, vol. 100x**

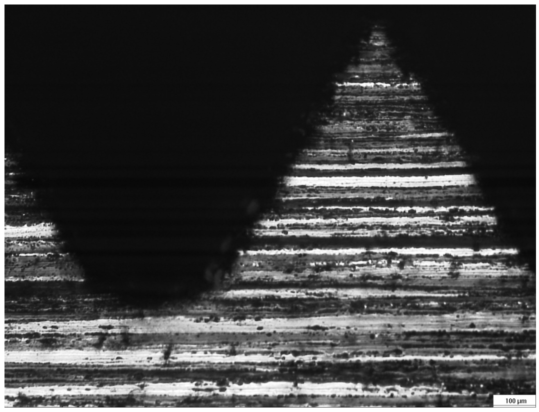

Fig. 4. **Microstructure – longitudinal section, Vol. 50x, deformed fibrous structures**

They are here acquainted with the practical preparation of such samples and their evaluation on the microscope. For example, from Fig. 4 it is evident that in the crack area the material has a deformed fibrous structure, which indicates that the material is reinforced, which can cause a crack. This means that before machining the blank was probably exposed to inappropriate technological processes [8; 9].

The next step to defect identifying which is possible to do and with what students must be familiar is the microscopic analysis using electron microscopy (Fig. 5-7), where it is possible to realize the EDX analysis (Fig. 8), too. These analyses can reveal the causes of defects for the presence of intermetallic particles, extraneous elements, the fracture character, the presence and arrangement of dislocations, etc [10].

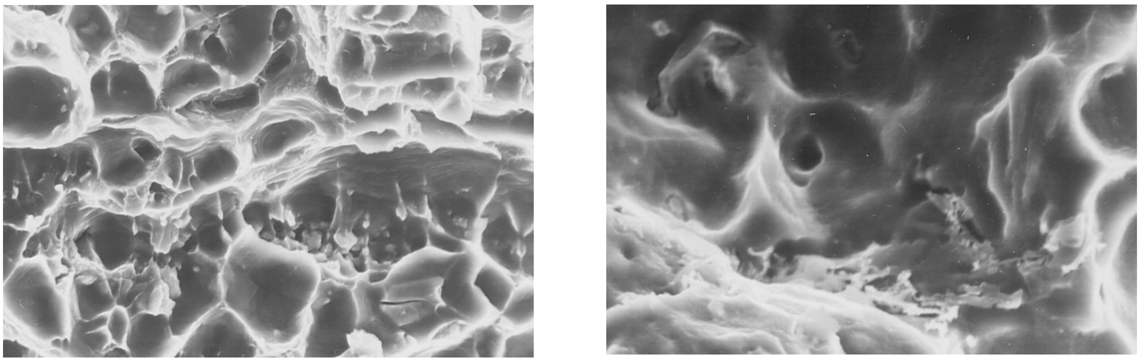

Fig. 5. **Transcrystallic ductile fracture – images from electron microscope**

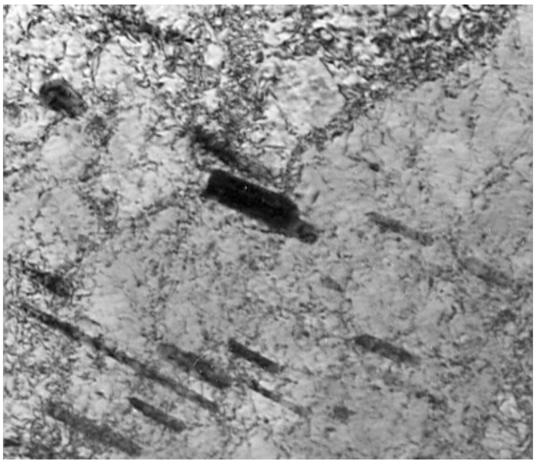

Fig. 6. **Substructure outside cracks**

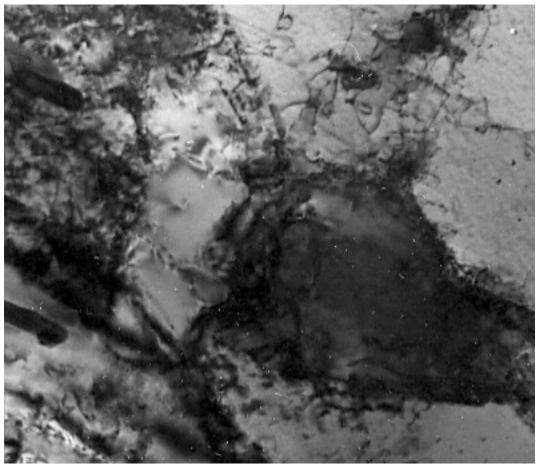

Fig. 7. **Substructure in crack – high density of dislocations**

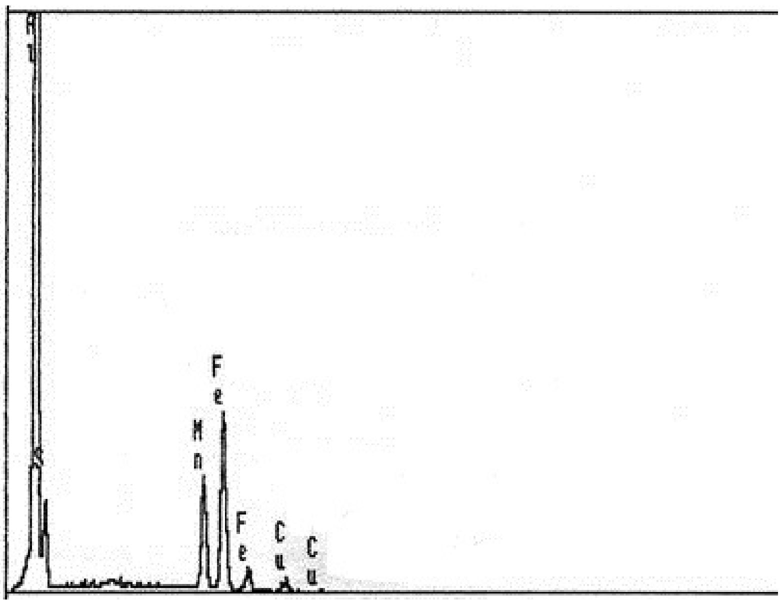

Fig. 8. **EDX analysis example of intermetallic particles**

Conclusion

The aim of this paper was to show the possibility and methodology of teaching in the field of materials at FPTM. Here the metallographic identification of defect possibilities are shown to the students, which are applicable to most materials and familiarity with this issue is for the students engaged in the study of material field especially important because these practical examples and procedures make this issue available for students. These identifications are especially important for the optimization of the production process, resolution of complaints, etc. It is obvious that the analysis and identification of the defects that arise in the manufacturing process, place high demands on the worker, when is just as well, when these facts students learn in the course of study, so on, lab equipment. Students should be familiar with the process of identifying defects, which must contain:

- complex records and documentation for each defect (complaint),
- careful recording and distribution of defects generated in the manufacturing process – complaints (usually standard, enterprise-dials processed according to the focus of the company),
- practical experience in the evaluation of the material,
- knowledge of the technology of the whole production process,
- ability to perform a complex analysis (if necessary even outside the laboratory),
- necessary instrumentation, including the possibility of taking photographs.

References

1. Naprstkova N. Making of experiment for student usage, Engineering for Rural Development, 2011, Jelgava, Latvia, pp. 58-563, ISSN 1691-3043
2. Kuśmierczak S. Tvorba didaktickych pomucek v ramci studentskych praci na KTMI FVTM UJEP. Strategie technickeho vzdelavani v reflexi doby. UJEP, 2009, ISBN 978-80-7414-126-3
3. Kuśmierczak S. The Usage of Confocal Laser Microscope by Solving Students Projects, International Miltidisciplinary Konference, 2011, Nyíregyháza, Hungary, pp.149-152,
4. Stasiak – Betlejewska R., Borkowski S. Stability of the Quality of Pipes of the Seam. Quality Materials Improvement, 2007, EDIS Publishing company, University of Żilina, Żilina, Slovakia,. ISBN 978 – 80 – 8070742 - 2.
5. Kalincová D. Skusanie mechanickych vlastnosti materialov – prehlad meracich metod a zariadeni. In Zvyšovanie efektívnosti vzdelávacieho procesu prostredníctvom inovačných prostriedkov. KEGA 3/6370/08., 2010, TU vo Zvolene, Zvolen. Slovakia, pp. 13-26. ISBN 978-80-228-2166-7
6. Kopec B. and the collective. Nedestruktivni zkouseni materialu a konstrukci. 2008, CERM, Brno, 571 p. ISBN 978-80-7204-591-4
7. Michna Š., Kuśmierczak S. Technologie a zpracování hliníkových materiálů., UJEP. Ústí nad Labem, 2008, ISBN 978-80-7044-998-1
8. Michna Š. Kuśmierczak S. Praktická metalografie, 2012, UJEP, Ústí nad Labem, Czech Republic, 245 pp. ISBN 978-80-7414-503-2
9. Michna Š. Kuśmierczak S., Bajdura M. Metalografie – metody a postupy. 2010, Adin, Prešov, Slovakia, 192 pp., ISBN 978-80-89244-74-4
10. Michna Š., Lukáč I. Praktická fraktografie. 2012, UJEP, Ústí nad Labem, Czech Republic, 237 pp. ISBN 978-80-7414-496-7