MAKING OF EXPERIMENT FOR STUDENT USAGE

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Abstract. The paper describes the design of the experiment, through which FPTM students can participate in influence analyzes of different hard particles caused by inoculation and modification of certain aluminum alloys. Such analyzes are currently solved at DTMI FPTM JEPU in Ústí nad Labem and engaging students in such experiments is one of such opportunities for students themselves to gain practical experience and knowledge from the experiment itself and also to try using different instruments, which are available at the DTMI FPTM.

Keywords: experiment, practical experience, alloy, devices.

Introduction

Involving students in solving practical problems is an important component of their studies to help them gain practical experience and skills that can then be used in their future career. The article describes the design of a longer experiment, in which the solutions are, and it will involve the students of the Department of Technology and Material Engineering, Faculty of Production Technology and Management, Jan Evangelista Purkyně University in Ústí nad Labem. This will give them, of course, not only practical experience with various instruments at the department, but they will also get familiar with the implementation and conduct of various tests and procedures.

The development of contemporary engineering is increasingly, directly associated with the development and use of new metallic materials.

The students will learn not only about the theoretical foundations (e.g., preparation of cuts from experimental materials – there they have to be familiar with the basic division of aluminum alloys and their composition, as well as identify the theoretical foundations of wear of cutting tools and materials that are used to this, etc.) but they will also get practical experience in implementing the heats of experimental materials, the NC programming, they will find out how such an experiment is planned and what, and how it is possible to analyze and proof.

Experiment preparation

At the DTME FPTM JEPU there is now also the longer-term research addressed, which concerns the detection and analysis of some properties of certain aluminum alloys. In this research, the students of DTME are also involved.

To prepare the experiment a basic search procedure must be done first. In it one of the students mapped out the basic problems of casting aluminum and aluminum alloys, their types and distribution and it is focused on aluminum alloys like Al-Si (silumin). Here the student got acquainted with practical information on the composition of materials, their properties and their uses. This information was also needed to organize and compile them into a more coherent whole. In this activity, students also participated.

As one of the most important parts of the research is also studying the impact of inoculation and modification of certain alloys of Al-Si on their properties in machining, there are students involved in the acquisition and compilation of basic information, too. Beyond teaching the curriculum they had become familiar with the problems of casting aluminum alloys, with the purpose and consequences of modifying the inoculation. Because these adjustments are made by certain elements and their compounds, formed in these alloys inter alia a hard intermetallic phases, which may affect the wear of the cutting tools and so the students also had to bring in greater details and deeper issues such as wear of the cutting tools (Fig. 1) [1].

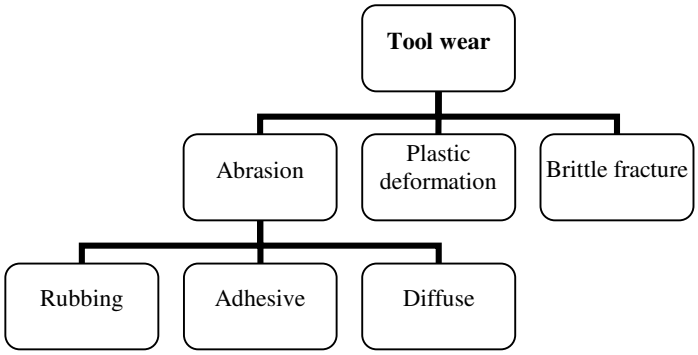


Fig. 1. **Kinds of tool wear**

All the necessary research and collection of information theory was the next step for the planning of the experiment, in solution of which the students will participate. Already in this proposal the students were again involved and they will be also involved in carrying out of the specific test.

Experiment design

The very design of the experiment in which the students participate and are involved will broaden their knowledge, practical skills and experience; therefore the possibilities of various tests that can be prepared to make samples are mapped. The basic scheme of this proposal is in Fig. 2.

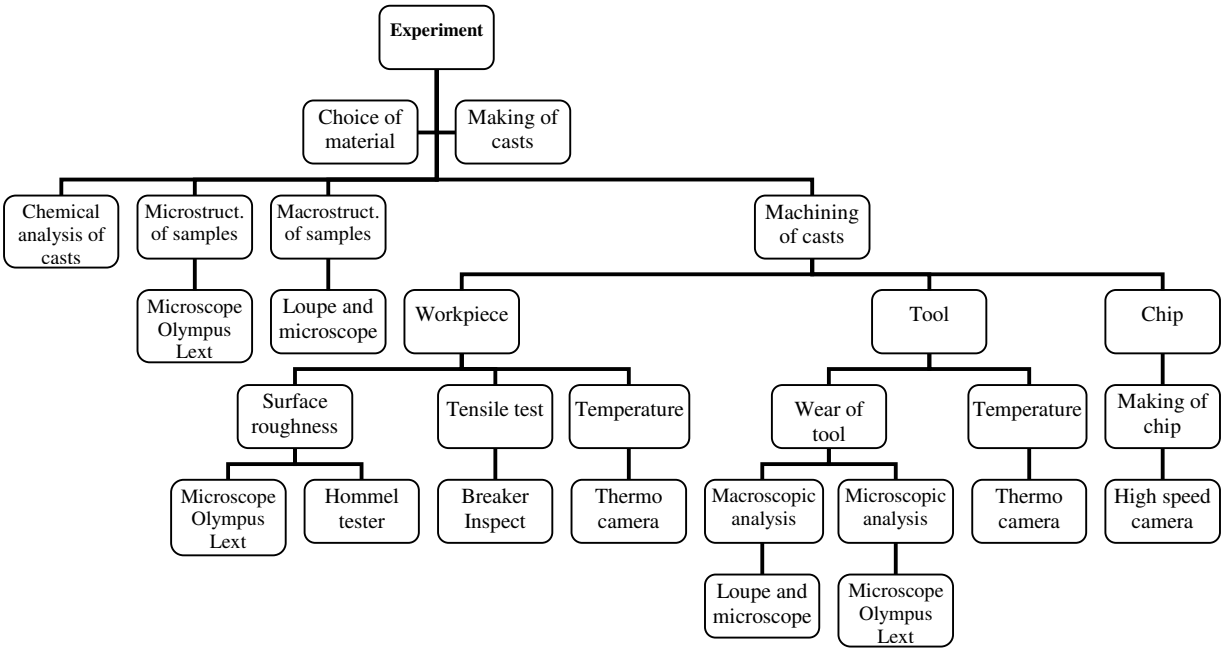


Fig. 2. **Design of experiment**

This scheme (Fig. 2) shows the possibility of the proposed experiment to involve the use of various equipment, which is at DTME FPTM available. The aim of this experiment is, as already stated above, to analyze the influence of hard intermetallic particles formed during inoculation or modification of certain aluminum alloys of Al-Si on wear of the cutting tool during machining. This proposal can be considered as instructions on how to proceed in solving the research task and can be used for further work with students [2].

Making of samples

The first step was to describe for students the procedure for making of samples. In this part the students test in practice the calculations for the necessary load types, types of melts and become familiar with the course of this cast. They will modify and inoculate the created alloys with various elements. All of them get familiar with the equipment and its possibilities, and the theoretical concepts for them become a reality. For this case, at DTME a metal form (Fig. 3) is available by help of which they will create all necessary casts. Melting will take place in an electric furnace, which is at DTME

for similar purposes also available. For each type of material at least three meltings will be made (for any content inoculant or modifier).

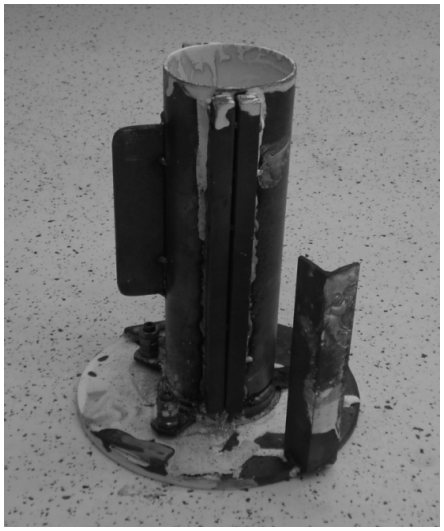


Fig. 3. **Metal mould**

Machining of samples

The next step is cutting the samples obtained after melting of materials. Here, the students also learn about using CAD/CAM systems and NC programming problems, because all processing is done on the CNC machine SUF 16 (Fig. 4) which is in fact available at DTME currently the best (albeit with certain restrictions) in constant cutting machining conditions in order to compare the effect of the prepared materials for cutting tools. The students therefore must also establish NC control programs for machining of samples.

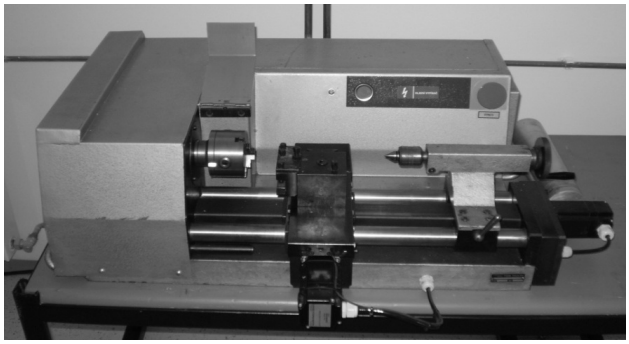


Fig. 4. **CNC machine**

The resulting castings will be machined and aligned to the basic default size and then machined in specified constant conditions in order to evaluate the potential impact of solid particles in the material on the cutting tool material. Processing will take place at a certain diameter. The remaining machines will make sticks for testing on the breaker (the students make the NC control program for the production of the sticks for breaking) [3].

Design of testing and its evaluation

At DTME instrumentation was mapped, and on this basis, proposals were elaborated for evaluation and analysis tests, which can be performed directly or after working with it. As previously stated, the primary task is the identification and analysis of tool wear after machining of various alloys of Al-Si tip, but it is necessary to perform a number of further analysis and testing too to get relevant results.

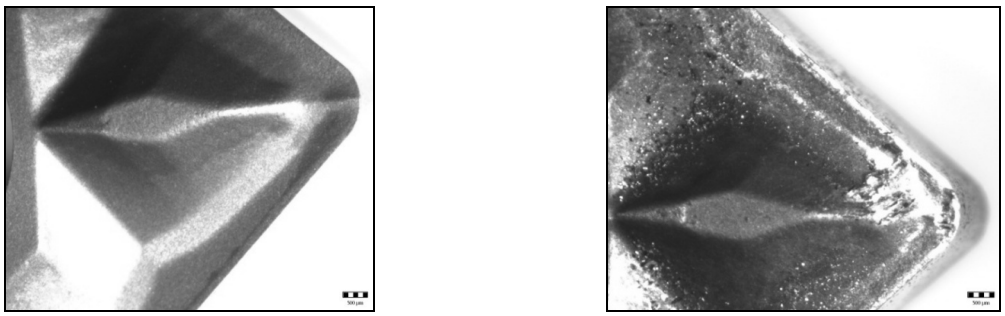
After a survey of the KTMI, in which the students also participated, some mechanical and metallurgical tests were designed (static tensile test, surface roughness, microstructure and macrostructure analysis, chemical composition analyses, etc.).

- *Macroscopic analyses of tool wear (up to about 50x magnification)*

First, the tool will be evaluated macroscopically. For this purpose at KTMI the microscope SZX10 Olympus is used (Fig. 5).

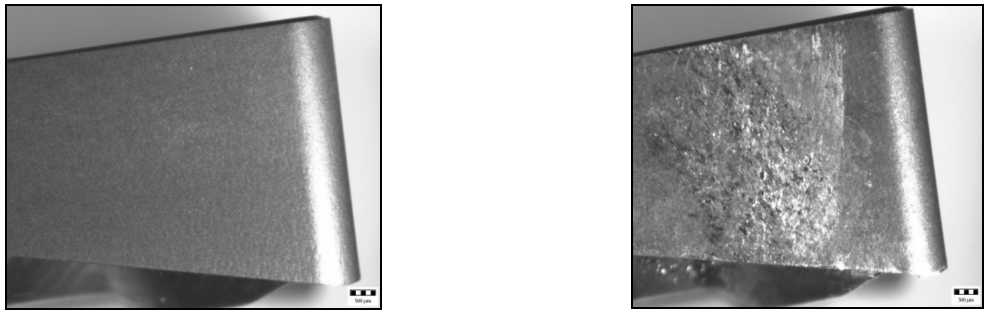
Fig. 5. **Microscope Olympus SZX10**

Figures 6 and 7 show examples of used and unused cutting blades, in which the participating students determine the type and size of wear.



a) blank cutting blade b) used cutting blade

Fig. 6. **Example of cutting blade top cutting surface CNMS 120408 magnified on the microscope SZX10**



a) blank cutting blade b) used cutting blade

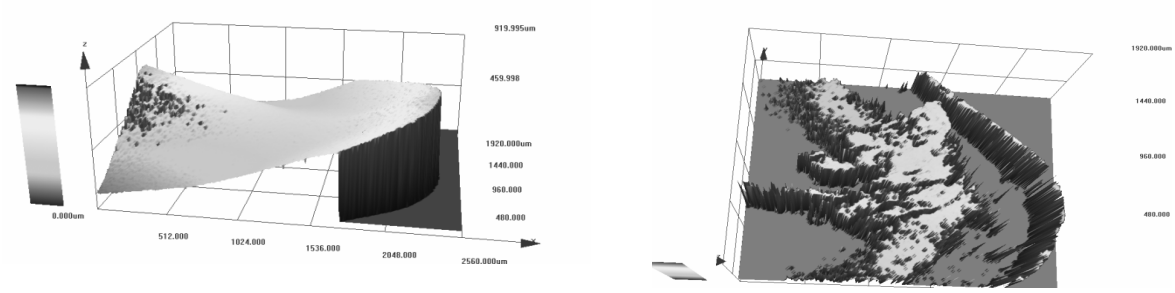
Fig. 7. **Example of cutting blade back edge CNMS 120408 magnified on the microscope SZX10**

- *Microscopic analyses (magnification of about 100x)*

It is also possible to analyze the cutting blades plates on the confocal microscope Olympus LEXT OLS 3100. Figures 8 and 9 show examples of the possibilities of this microscope through which it will be possible to obtain additional relevant information concerning the wear of the cutting tools.

a) blank cutting blade b) used cutting blade

Fig. 8. **Example of cutting blade top cutting surface CNMS 120408 magnified on the laser microscope** *LEXT*



a) blank cutting blade b) used cutting blade

Fig. 9. **Example of cutting blade back edge CNMS 120408 magnified on the microscope in 3D mode**

On the cutting blades using the microscopes it is possible to measure different values (e.g., v_B), which are then evaluated. For these purposes, the microscopes are equipped with appropriate software.

- *Static tensile test*

Whereas at DTME a tensile machine is also available, it was further suggested that the specimens machined after appropriate treatment (see above) were subject to the tensile test according with the standard ČSN 420310th

- *Mass spectrometric analysis*

It was also suggested that the as-cast samples were analyzed by the mass spectrographic analysis; a device for this method will soon be available at DTME. This analysis determines whether the casting is required by the appropriate number of elements.

- *Macrostructure and microstructure of samples*

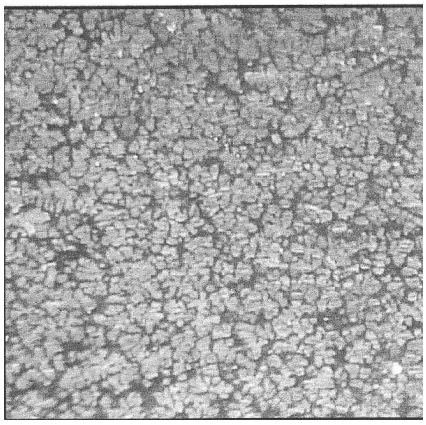


Fig. 10. **Example of macrostructure AlSi7Mg0.3 alloys with an inoculant containing 0.05 % Ti [4]**

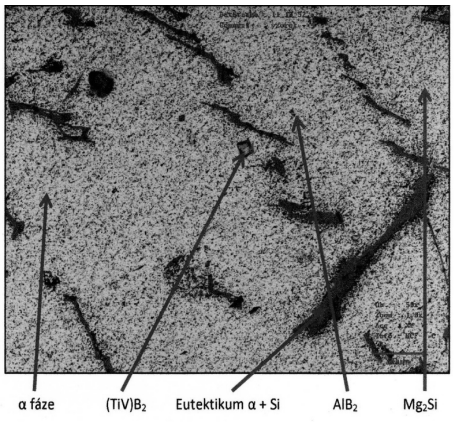


Fig. 11. **Example of microstructure AlSi7Mg0.3 alloys with an inoculant containing 0.05 % Ti, magnification 500x [4]**

The performed next step will be the analysis of macrostructure of castings and determination whether the casting has been under the right conditions and analysis of the inoculation and modification effect on the structure of alloys. Figure 10 shows one example of macrostructure of the investigated alloys.

Microscopic observation of samples of cast alloys is important. Here the students learn, and try to practice sample preparation for microscopic examination. Figure 11 shows one example of the microstructure of the investigated alloys.

- *Measurement of surface roughness of workpiece*

Another measurement that is possible in these experiments to perform at DTME is measuring of the roughness of the machined surface. For this purpose there is a profilometer Hommel Tester T 1000 available and it is possible to use the laser microscope Olympus Lext. The students will learn to work with these devices and gain practical experience in the evaluation of the machined surface [5].

- *Temperature display in machining and chip formation in turning*

It is also possible in solution experiments to measure the temperature during operation. For this purpose, it is possible to use a thermal camera P620. It is also possible to perform recordings of the chips in the process of cutting by high speed camera i-SPEED. Here, the students can learn about the functions and how to use the two top devices, which are found at DTME.

Conclusions

The present paper describes the design of the experiment in the course of which students are already involved and will continue. For students such contact with a real solution to a problem is from the pedagogical point of view very useful, because there they are confronted with actual planning of experiments, with their real progress, they can participate in data collection and work on their subsequent evaluation. They will also gain some experience with service equipment, which would normally be unable to get. They extend their knowledge and concepts about scientific work; acquire some habits that can be good for them in their future job. The above text shows that students acquire knowledge from a large range of engineering disciplines (materials, metallography, technology, thermal effects, etc.) which for them may be important in further use.

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