Universitatea *Transilvania* din Braşov

HABILITATION THESIS

SUMMARY

CONTRIBUTIONS REGARDING THE COMPETITIVENESS GROWTH OF THE ALLOY STEELS TOOLS

Domain: Industrial Engineering

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BRASOV, 2016

(A) SUMMARY

The habilitation thesis reflects some of the author's achievements, in more than 30 years since from the graduation of the university studies. More than 25 years of my activity took place in academic education. I think that my professional evolution covered the necessary and natural steps for such an approach (supporting of the habilitation thesis). I started as process engineer, I continued as design engineer and university teacher since 1990. The habilitation thesis presents the author's scientific contributions made to increase the quality tools used by the industry. The personal achievements in the research area were the basis of information for the articles published in the indexed ISI and BDI journals. Understanding that classical technologies have consumed the development-innovation capacity of new products, I considered that only the technologies combination is the path that, I must follow for performing the proposed researches. This is why that, researches were directed towards unconventional technologies that can be applied to the mentioned field. They already have some practical application or tend to be widely applied at industrial or semi-industrial level. The habilitation thesis presents the results of the green and renewable energy application in the materials domain for tools. The thesis is divided into three chapters.

The first chapter presents the evolution of cutting tools globally and what are the trends in the field. The evolution of tools used in the production process is closely related to the machine-tools domain. The connection is of strong dependency because the progress of machine-tools causes immediately the development of the new tools type, or model. The tools are those parts of the processing chain that allow exploitation to the full potential of the capabilities owned by the new machine-tools. The chapter begins by the presenting of the tools production evolution, globally. This shows that except the last crisis period, when their production decreased, actually, the sector began to show slight increases. The European Union occupied the first place in 2012 in the export tools and predictions show that the tools production will record substantial increases until 2020. From the viewpoint of the materials used in tools manufacturing, the study shows that high speed steels (HSS) will still be very processed. The information is surprising because many consultants and in various environments, it is approved the idea that this type of material have not such weight in the tools production. The overall outcome of the tools production permits to be intuited how important are improvements that can be made to the tools, regardless of the ways they do. Also, in this section are presented which are the most efficient manufacturing methods of the materials used to obtain tools. From the viewpoint of the material

and energy consumption, the tools manufacturing exclusively based on the chip removal process is most disadvantageous.

In the chapter II, I presented the influence of the applying unconventional technologies on the material properties used at the tools manufacturing and the behaviour in cutting of the tools obtained by such technologies. A negative aspect met in the cutting tools manufacturing is the high consumption of the high alloy steels, because of the majority production of the cutting tools is obtained by chip removal process. For this reason, the combining of the two classical technologies was the idea applied to increase the materials performances used for the tools. The applying of thermomechanical treatment to the tool materials has not been without obstacles. As a result of tests it was determined the dependence between the deformation resistance and the deformation process parameters: speed and temperature. The hardness and resilience tests performed on the thermomechanical treated materials allowed to decide, which is the optimum deformation degree applied in the time of the thermomechanical treatment. The thermomechanical treatment conditions established, the research continued with the cutting behaviour tests of the cutting tools obtained by this process. The habilitation thesis presents the attempt results performed with the disk-type of milling cutter (cutter disk) obtained by thermomechanical treatment. In all performed tests, the tools manufactured by classical method had a behaviour more worse than those treated thermomechanical. The applying of thermomechanical treatment was extended to other steels to see if the same effect is obtained. The studies show that when applying the additional plastic deformation, the wear behaviour is better than when this operation is missing. Another treatment that was applied to materials used for tools was to use concentrated energy sources. For this type of treatment, the classic alternative offered the most unfavourable results. A last attempt was the using of clean energy for the tool steels treatment. For the mentioned operation it was used the solar energy that allowed the specimens heating at temperatures recommended by the literature, more precisely over $1200^{o}C$. The preliminary processing of the results shows that this energy can be used successfully in such operation. Also, the chapter presents the finding of technical solutions for to accelerate the removing of the hard thin layers deposited on tools. The study was performed at the request of the industrial partner that activates in the field. The solution consists in the applying of a mechanical energy surplus in the bath with solution dedicated to the removal operation. The last part of the chapter shows the influence of the heat treatments on the alloy steels properties, for tools.

The last chapter presents the opportunities for increase the tools competitiveness, using simulation process or 3D modelling. The relation between, deformation resistance, deformation speed and temperature established in the second chapter and the calculus of the elasticity

modulus for the tested materials permitted the study by simulation of the semi-finished product plastic deformation, from the start to end. The simulation results are close to those achieved in reality. Another way to study what happens during cutting process is to create virtual machine tools. Using this technique shows that optimization tools can be made more easily and quickly, still the design phase of them.

The studies presented in the habilitation thesis, were performed on several processes to show that, because of the wide diversity of the tools materials and types is excluded the applying of a single technological process for all cases. The tool geometry, utilization domain and material are those that will indicate the technological process fittest for maximizing the tool performances.