

ADVANCED RESEARCHES CONCERNING LAPPING PROCESS

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Abstract: The paper present advanced researches approaches a topic of actuality in the machine manufacturing field, by combining the surfaces' lapping in processing some special materials (ceramics, composites) in conditions of minimum cost/ maximum quality, with modern technologies. There will be monitories, during the experimental researches: evolution of the chip removal forces' size; evolution of the temperature in the processing area; evolution of the vibratory phenomena; on line evaluation of the processed surface's roughness by the method of acoustic emission and/or by measuring the lapping solution's PH.

Key words: lapping, ceramics, composites, roughness, acoustic emission, PH.

1. INTRODUCTION

Advanced researches approaches a topic of actuality in the machine manufacturing field, by combining the modern trends in the manufacturing processes (surfaces' lapping) in processing some special materials (ceramics, composites) in conditions of minimum cost/ maximum quality, with modern technologies. There will be monitories, during the experimental researches: evolution of the chip removal forces' size; evolution of the temperature in the processing area; evolution of the vibratory phenomena; On line evaluation of the processed surface's roughness by the method of acoustic emission and/or by measuring the laping solution's PH.

The objectives of the advanced researches are:

- acquirement of knowledge, results but also experience into a top domain and the transfer of results toward the interested economic agents, both at national and international level;
- by partnership, the researches supports the development of a strong nucleus of research-development orientated to the target group formed by the economic agents having the main activity in the industry of new manufacturing materials;
- by the technical level proposed in the paper, also the aspect of technological integration is accomplished, accordingly to the quality standards of the European Union and also the dissemination of results.

The general objectives of the paper are: the continuous increase of the research-development

capability of the units involved in the partnership; to sustain the development of the integrated networks of institutions which will assure the adequate scientific and technical competence; connection to the European research thematic area concerning both the quality of the obtained results and also the requests of the European Union for conformity evaluation; to stimulate the institutions for participating in accessing the European programs of research-development.

The main specific objectives of the paper are: making functional a stand and a research program in the domain of lapping surfaces on special materials (ceramics, composites) and the realization of the stand with instruments necessary for process monitoring. There will be targeted the following aspects: monitoring of the lapping operation; mathematical modeling of the process methods; determination of the optimum domains for the parameters of the working regime; estimation in process, by the method of acoustic emission and/or by measuring the pH of the lapping solution, of the roughness for the processed surface; researches concerning the behavior in exploiting of the processed parts (resistance to wear, to corrosion, to fatigue).

Elaboration of mathematical models for the following aspects, extremely important for a finishing process:

- 1) modeling of the economic (optimum) domain for lapping, which, by establishing an objective function (minimum cost, minimum roughness etc.) and some restrictive functions (imposed by the technological system – speed, feed rates etc. and by the productivity, wear ratio etc.) to allow the determination of the optimum value (values) of the cutting speed (speed of the lapping disk), feed rate, for which the processing is done with minimum costs.
- 2) estimation of the exploiting behavior for the abrasive powder or paste by FEA on the stress, temperature, having as main objective to obtain the safety in exploiting.
- 3) mathematical modeling of the roughness for the processed surface, modeling based on the chip removal physics.
- 4) elaboration of some models for the wear of the lapping disk engrained with abrasive powder, at

lapping some ceramic and composite materials.

Situation at national level

The orientations of the researches are towards the commercial societies that realize finishing operations by lapping on ceramic and composite materials, which can obtain important benefits by optimizing the manufacturing technologies.

At national level, the researches in the domain of lapping are generally slightly relevant. Also, the researches in the domain of processing materials with special structure and destination (ceramics and composites) are quite few and insignificant.

Causes: weak material endowment of the research laboratories; insufficient knowing these modern processing methods; reduced use of special materials (ceramics and composites) in Romania.

Present trends at national level:

- generally the state or private enterprises face the situation to have imposed by contract: manufacturing machine parts with REDUCED degree of processing and resulting low prices – the new created enterprises have the advantage of a modern endowment from the start and of a strategic management, not of a survival management.
- the trend to invest in research is rather reducing, mainly because older technologies but having lower acquisition costs is preferred.

At national level, the exploiting of mechanical characteristics of metal parts, cast, forged, machined etc is costing from economic and energetic reasons.

These ceramic and composite materials excellently respond to the loadings from aerospace, aviation and military industry.

As priorities in this domain there are:

- at national level, the study of the composite materials started to be approached since the '70s. From the bibliography consulted, both from the country and from abroad, there result that the replacement of the metallic materials, strongly energy-consuming, is a major priority;

At national level, the economic agents appeal to external producers, because in the country this concernment does not exist. This project is born from the acute need of modernizing and re-technologisation encountered by the economic agents who primarily appealed to imports or to copying existing parts. After the economic agent specified its requests and reached to a conceptual concretization, Romanian specialists from the indigene research were claimed. The needs related to the increase of the economic agents' ability to adapt at the proportion and rapidity of the economy changes, have determined the attention attraction of some research-development teams which try - either modernizing of equipment – or a judicious material choice. Our team of specialists has passed through a study stage for this type of research, period in which the present trends in the domain at national level have been analyzed.

Because a specific characteristic of the modernization of the Romanian economy is imposed by the requests of the integration in the economic environment of the European Union, which presumes the increase of the

economic agents' capability to realize new or modernized products, technologies or services, accordingly to the European or international standards, especially on the European market, we considered as being of great interest the realization of a research concerning the finishing by lapping of these materials, considered as belonging to the future.

In the sense of researching these aspects, starting from the elaboration of the model to the prototype, there exists an experience of about few decades, very good results being obtained during this period, which encouraged the idea of participation in competition.

At national level there exist units of Research-Development, mainly in the military domain, which, on restricted segments, are frequently covering their own experience with very expensive licenses or with service secrets.

Situation at international level

Present trends at international level:

- ♦ composite and ceramics materials replace more and more the classic materials
- ♦ these materials are recommended also by their physical-chemical-mechanical and exploiting properties
- ♦ American and Japanese company's trend to use plane lapping in top domains, such as electronics and especially in manufacturing of computer compounds, were plane contact surfaces having very small roughness are demanded (figure 1).

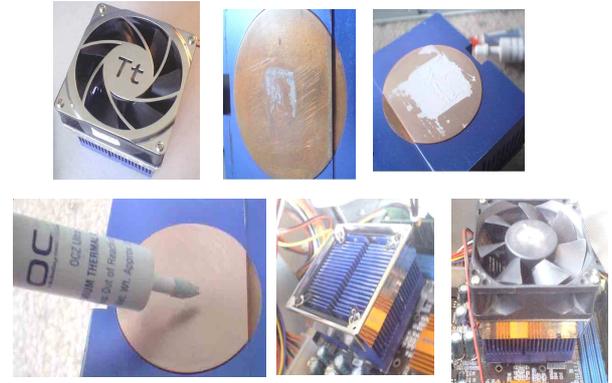


Fig.1. Fields that use the lapping

Worldwide, there exist a number of universities and research institutes having a "tradition" in the activity from this domain. For giving only a few examples, we mention: Catholic University from Louvain-la-Neuve, Belgium, Department IPCIM conducted by Prof. PhD F. Delannay, University Compiegne, Department conducted by G. Beranger, University Quebec, Canada, Department conducted by J. Massonave, Alain Thorel, Mines School Paris-Centre of Materials, France, Charles T. Lane, DURALCAN, San Diego, U.S.A., R. Schaler, Federal Polytechnic School of Lausanne, Atomic Institute, Switzerland. Because lately there have been appeared a lot of carbide fibers producers such as: Torayka, in Japan, Akzo in Holland, there must be mentioned that the materials necessary to this research are at reachable prices and having adequate physical-mechanical characteristics.

We can not neglect that the last type of AIRBUS 380 airplane is made 80% of composite materials, both with

metallic matrix and with organic matrix (preponderantly epoxidic with carbide or glass fiber).

Engineers can design composite materials enough rigid and strong for responding to precise loadings, ensuring the number of layers, their nature and thickness (matrix and reinforcement) the sequence of packing and orientation of fibers. The dimensioning methods are based on using computers with evolved software package of FEA type. Each design shop protects its experience under very expensive patents and licenses.

The design of the technological equipment and of the material recipes have become inaccessible to indigene economic agents and for this reason a scientific approach of this issue in universities and in research-development centers is necessary.

The degree of novelty and complexity of the researches consists from the fact that there are not known till now other researches effectuated on the monitoring of the finishing operations by lapping of special materials (composites and ceramics) in our country; it is the first approach of such a research topic.

The complexity of the research, the results reproducibility and the exactly rigorously quantification of the roughness of the processed surface, are the support of the researches that will be approached. From methodological point of view, the reach of the measurable objectives will represent the warranty of this project's quality.

The complexity of the research comes also from the multitude of factors that participates in project's realization: 1. the nature of the structure compounds from the interface; 2. technological conditions for obtaining optimum quality of surface; 3. chemical composition of the used type of abrasive; 4. the volume of the experimental researches etc.

All the materials that will be used can be aquired from the market at accessible prices and having adequate physical-chemical and mechanical characteristics.

The complexity of the proposed theme comes also from the complexity of the equipment to be used. For detailing, the scheme from fig.2 will be used.

The program is stipulated to be developed during three years, with further development on directions established from the strategic requirements of the scientific research and teaching activities, from the development of collaborating partnerships with machine manufacturing or service companies and from the perspectives of relaunching/development/integration on medium and large term of Romanian industry.

The research is based on the application of new technologies of manufacturing and quality control.

The accent will be set on using the already existing material endowment and on completing it in the deficitary domains (within the limits of the financial resources).

Theoretical and experimental researches in the field of finishing technologies by lapping are quantitatively few in Romania, while in countries as Germany, USA, Japan these methods are currently used in top industries.

The field of machining special materials (ceramics, composites) is a present domain at worldwide level, but quite slightly approached at national level.

The opening after year 2000 towards new technologies (including IT) made topics of this complexity to be approached also in the Romanian technical university environment.

The chronic lack of funds, the weak performances and the lack of strategic vision in machine manufacturing industry made these not having finality and applicability.

The beginning of re-launching of the machine manufacturing industry and generally of the economic re-launching allow expectations for the not very far future, for the researches in top fields to take advantage of industrial partners and the results of the researches to be applied.

The adhesion to EU and the globalization phenomenon force us to produce quality and cheap for existing and prospering.

The application of quality engineering techniques will simplify the experimental process, offering at the same time enough information for the experimental results to be reproducible in workshop conditions.

In the project, there is considered the setting in function of stand and research program in the field of lapping surfaces on special materials (ceramics, composites) and stand's completing with instruments necessary to process monitoring (according to scheme from figure 2).

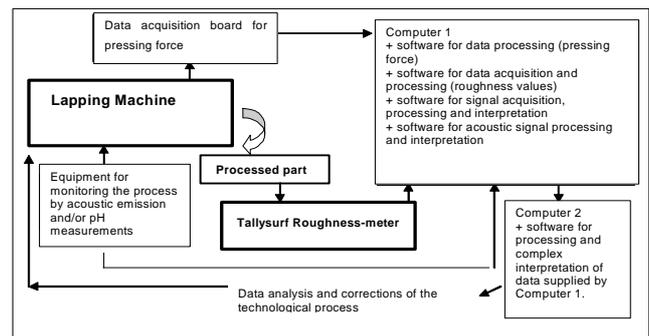


Fig.2. General equipment used for lapping process

2. EXPERIMENTAL METHOD

Experimental determinations will be made on a lapping machine, processing different composite and ceramic materials. There will be considered the use of ceramic and composite materials, on one hand for the construction of the lapping disks and on the other hand, as processed materials. The materials to be processed will be firstly judiciously selected, considering the necessity of finishing processing by lapping.

In this project proposal, the following aspects are considered: monitoring of the lapping operation; mathematical modeling of the processes; determination of the optimum domains for the parameters of the working regime; estimation, in the process, by the method of acoustic emission and/or by pH measurements, of the roughness for the processed surface; researches concerning the behavior in exploiting for the processed parts (wear, corrosion and fatigue resistance).

As the first results will be obtained, there will be proceeded to their dissemination in academic and

industrial environment through the specialty magazines, conferences, leaflets, Internet.

Experiments planning and programming will be done using Taguchi method and will target the following objectives:

- obtaining a sufficient quantity of information upon the lapping process in conditions of minimum possible consumption of material and energy;

- establishing an experimental volume adequate to correct data obtaining.

- analysis of the influence of some process parameters upon some characteristic process results, such as: surface quality, durability of the lapping disk, process economicity.

- analysis of the interdependence between the process parameters and its influence upon the process' results.

From the proposed research program there are outstanding the following aspects with character of innovative scientific research:

- Introduction of the concept of lapping of some ceramic materials with conventional powders or pastes (modified or not) related to the fact that from the study of the present technologies at worldwide level these operations are made in two ways:

1. using diamonded powders or pastes

2. using abrasive powders or pastes with CBN

- Elaboration of some mathematical models for the following aspects, very important for a finishing process:

1. Modeling the economic (optimum) domain of lapping, which, by establishing an objective function (minimum cost, minimum roughness etc) and some constraints (imposed by the technological system – speed, feed rates etc. and by the productivity, wear ratio etc.) to allow the determination of the optimum value (values) of the cutting speed (speed of the lapping disk), feed rate, for which the processing is done with minimum costs.

2. Estimation of the exploiting behaviour for the abrasive powder or paste by FEA on the stress, temperature, having as main objective to obtain the safety in exploiting.

3. Mathematical modeling of the roughness for the processed surface, modeling based on the chip removal physics.

4. Elaboration of some models for the wear of the lapping disk engrained with abrasive powder, at lapping some ceramic materials.

- Introduction of the Taguchi experimental techniques, taking into account the increasing trend of its implementation at international level. The working method is of feed-back type, providing the possibility of objectively measuring the results, being an essential condition for obtaining qualitative results.

The instruments and the equipment which will be used are: lapping machine endowed with all the necessary control and measuring equipment, tools and accessories, data acquisition boards, roughness-meters, optical microscopes type IOR, electronic microscope with sweeping or by transmission, equipment for fractal analysis, necessary software etc.

The main objective of the project consists in developing

researches concerning the determination of the optimum technology for finishing by lapping for special materials (ceramics and composites).

The problems proposed for solving are:

1. Making functional a stand and a research program in the domain of lapping surfaces on special materials (ceramics, composites) and the realization of the stand with instruments necessary for process monitoring.

There will be targeted the following aspects: monitoring of the lapping operation; mathematical modeling of the process methods; determination of the optimum domains for the parameters of the working regime; estimation in process, by the method of acoustic emission and/or by measuring the pH of the lapping solution, of the roughness for the processed surface; researches concerning the behavior in exploiting of the processed parts (resistance to wear, to corrosion, to fatigue).

2. Elaboration of mathematical models for the following aspects, extremely important for a finishing process: modeling of the economic (optimum) domain for lapping, which, by establishing an objective function (minimum cost, minimum roughness etc.) and some restrictive functions (imposed by the technological system – speed, feed rates etc. and by the productivity, wear ratio etc.) to allow the determination of the optimum value (values) of the cutting speed (speed of the lapping disk), feed rate, for which the processing is done with minimum costs; estimation of the exploiting behavior for the abrasive powder or paste by FEA on the stress, temperature, having as main objective to obtain the safety in exploiting; mathematical modeling of the roughness for the processed surface, modeling based on the chip removal physics; elaboration of some models for the wear of the lapping disk engrained with abrasive powder, at lapping some ceramic and composite materials.

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