UNIVERSITY POLITEHNICA BUCHAREST
FACULTATY MATERIALS SCIENCE AND RNGINEERING

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ABSTRACT

PhD Thesis

STUDIES AND EXPERIMENTAL RESEARCH ON MECHANICAL BEHAVIOR AND CAVITATIONAL EROSION BEHAVIOR OF AN ALUMINUM ALLOY OF THE 7075 SERIES

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REZUMAT

Prezenta lucrare structurată în şapte capitole şi își propuse realizarea și îndeplinirea următoarelor obiective în domeniul aliajelor de aluminiu tip 7075: determinarea comportării mecanice a tablelor din aliaj de aluminium tip 7075, pe diferite grosimi, în vederea identificării reproductibilității acestora în timpul procesării la ALRO SA; determinarea influenței diferitelor tratamente termice de îmbătrânire asupra comportării mecanice a aliajului de aluminiu tip 7075; determinarea comportării la eroziunea cavitațională a aliajului de aluminiu 7075 în diferite condiţii de tratament termic pentru a putea identifica mecanismele de propagare a fenomenului cavitațional, la această clasa de materiale metalice; identificarea principalelor elemente structurale care conferă acestui aliaj de aluminiu proprietăți mecanice și de rezistență la eroziunea cavitațională deosebite; Realizarea unei corelații structură - comportare mecanică - comportare la eroziunea cavitațională la aliajul de aluminiu de tip 7075. Prin realizarea lucrării autorul aduce câteva contribuţii originale, respectiv: realizarea unei analize structurale complete și complexe a epruvetelor experimentale din aliaj de aluminiu tip 7075, în diferite stări structurale, fie turnat, fie laminat, urmat de diferite tratamente termice de îmbătrânire, corelată cu evaluarea rezistenței la eroziunea cavitațională şi realizarea unei analize complete statistice efectuată asupra valorilor caracteristicilor mecanice ale tablelor din aliaj 7075, aflate în stare de livrare (T651) şi grosimi diferite, care a evidențiat faptul ca procesele tehnologice aplicate au condus la obținerea unor caracteristici mecanice corespunzătoare, fără abateri de la limitele de toleranță, cu mare reproductibilitate si stabilitate.

CUVINTE CHEIE: ALIAJ DE ALUMINIUM, TRATAMENT TERMIC, ALIAJ 7075, EROZIUNE CAVITAŢIONALĂ, ANALIZĂ FRACTOGRAFICĂ

ABSTRACT

This paper structured in seven chapters aims to achieve and achieve the following objectives in the field of aluminum alloys type 7075: determining the mechanical behavior of aluminum alloy sheets type 7075, on different thicknesses, in order to identify their reproducibility during processing at ALRO SA; determination of the influence of various aging heat treatments on the mechanical behavior of aluminum alloy type 7075; determination of the cavitational erosion behavior of aluminum alloy 7075 under different heat treatment conditions in order to identify the mechanisms of propagation of the cavitational phenomenon to this class of metallic materials; identification of the main structural elements that give this aluminum alloy outstanding mechanical and cavitational erosion resistance properties; Making a correlation structure - mechanical behavior - behavior to cavitational erosion to aluminum alloy type 7075. By carrying out the paper, the author brings some original contributions, namely: carrying out a complete and complex structural analysis of experimental specimens made of aluminum alloy type 7075, in different structural states, either cast or laminated, followed by different thermal aging treatments, correlated with the evaluation of resistance to cavitational erosion and the realization of a complete statistical analysis performed on the values of mechanical characteristics of alloy sheets 7075, in delivery state (T651) and different thicknesses, which highlighted the fact that the applied technological processes led to obtaining appropriate mechanical characteristics, without deviations from tolerance limits, with high reproducibility and stability.

KEYWORDS: ALUMINUM ALLOY, HEAT TREATMENT, ALLOY 7075, CAVITATIONAL EROSION, FRACTOGRAPHIC ANALYSIS

CONTENT

Chapter 1 is entitled "Research on elements of physical metallurgy on aging heat treatments applied to alloys of the 7xxx series". A documentary synthesis is made regarding: hardening mechanisms of aluminum alloys, aging phenomenon in aluminum alloys, highlighting the main heat treatment of aging of 7XXX series alloys, influence of alloying elements, aging treatments in one or several stages, heat treatments of backgrowth and reaging, mechanical properties of aluminum alloys type 7075 after applying various heat treatments. Chapter 1 concludes with elements from the literature on the research of the behavior and resistance to cavitation erosion of aluminum alloys.

Chapter 2 is entitled *"Research Material and Methodology"* and includes two subchapters: one aimed at explaining the types of materials and equipment, as well as the expressive procedures used in experiments, and the second regarding the description of the research program carried out in order to achieve the objectives of this paper, as illustrated in fig. 1.

Chapter 3 is entitled "*Structural Analysis of Experimental Samples of Type 7075 Aluminum Alloy*". The chapter includes the results of optical metallographic analysis and X-ray diffraction analysis performed on investigated materials in different heat treatment states. The analysis highlighted the following structural aspects.

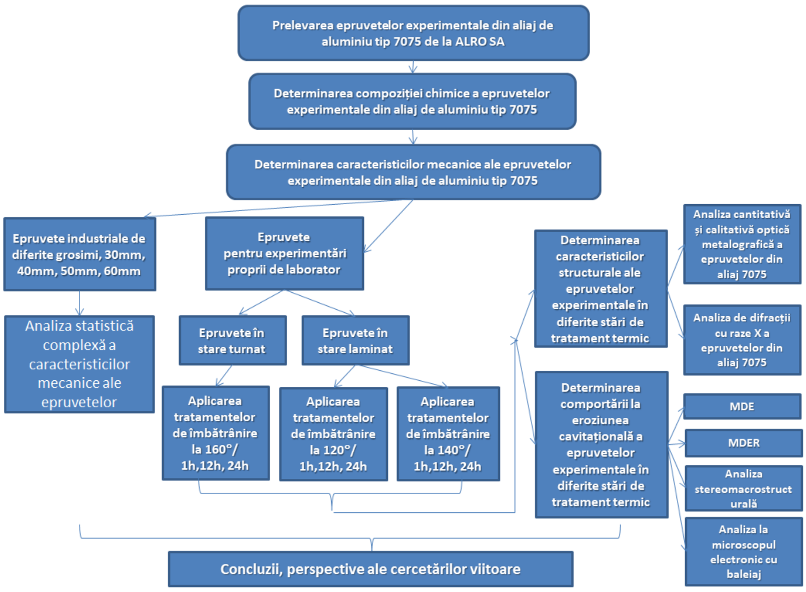
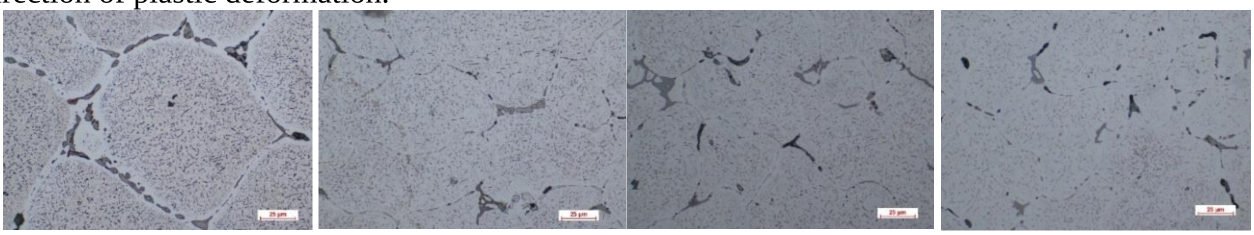


Fig. 1- The experimental program of the research undertaken within the framework of this doctoral thesis

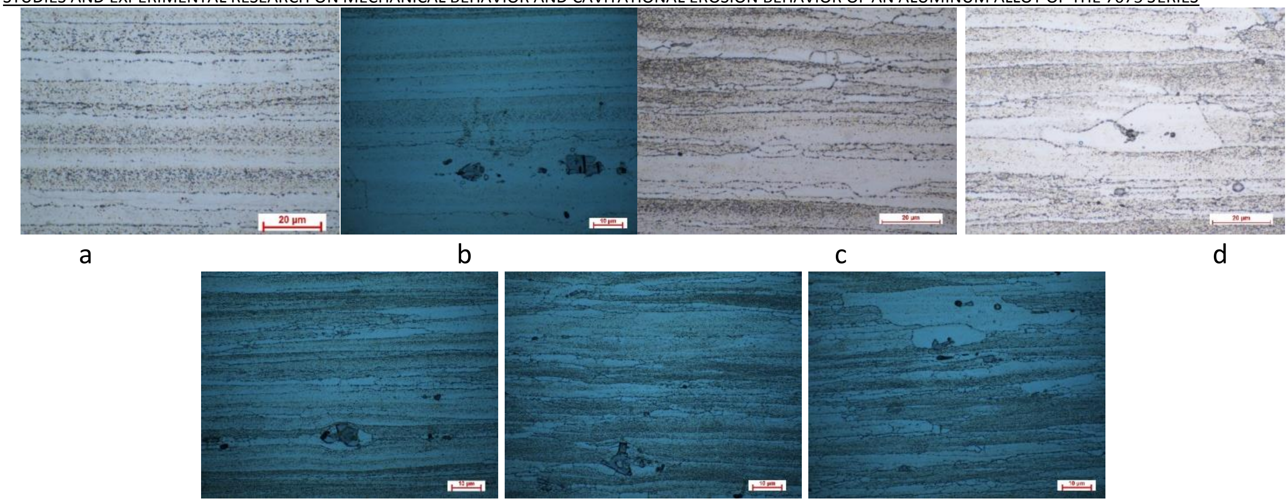
The structure of aluminum alloy specimens type 7075, in cast state (fig.2) consists of solid solution α and eutectic interdentritic, as well as two types of precipitates, respectively coarse interdentritic precipitates and finely distributed matrix precipitates and intradentritics. The dendritic structure is accompanied by interdendtitic precipitation of the eutectic Interdendritic precipitates are large in size (3-5μm), gray in color, almost with continuous precipitation. By applying an aging heat treatment at 160°C, with different holding durations, precipitates and eutectic dissolve and fine reprecipitation, both intergranular and intragranular (fig. 2b - fig. 2d). By increasing the holding time to 160°C, from 1 hour to 12 hours and 24 hours, the interdendritic particle size is finished and the eutectic proposition is considerably decreased until it disappears.

The structures of specimens in laminated T651 state, either blank sample (fig. 3a) or samples with different heat ageing treatments (fig. 3b – fig. 3) are similar. Thus, at the blank specimen in laminated condition, fig. 3a, the structure consists of solid solution α and finely distributed precipitates in matrices with orientation in the direction of rolling. The structure is typically fibrous. By applying thermal aging treatments at 120°C, fig. 3b- fig. 3D, the structure remains fibrous, with finely distributed precipitates in solid solution matrix α oriented in the direction of lamination. When applying thermal aging treatments at 140 ° C (fig. 3e - fig. 3g) it is noted the increase in the thickness of the size of the deformed grains, the thickness changing from 2-4 μm (to a holding duration of 1 hour), at 4-6μm (at a holding time of 12 hours) and 10-12μ m (at a holding duration of 24 hours). The structures remain fibrous, with finely distributed precipitates in the solid solution α, oriented in the direction of plastic deformation.



a b c d

Fig. 2- Microstructural aspects of aluminum alloy specimens type 7075, cast state (a) and various heat aging treatments (b- 160°C/1h; c- 160°C/12h; d-160°C/24h)

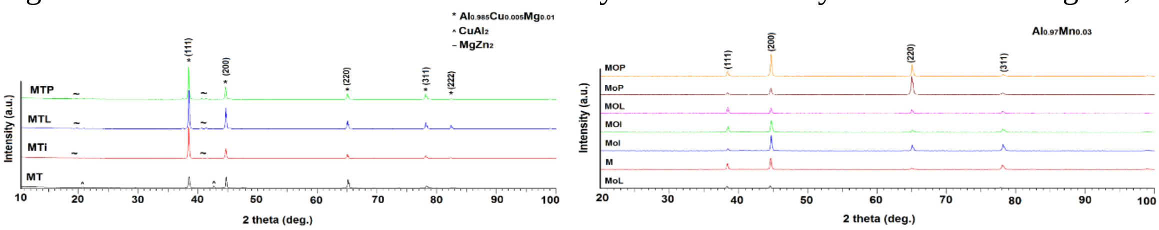


a b c d

e f g

Fig. 3- Microstructural aspects of aluminum alloy specimens type 7075, cast state (a) and various heat aging treatments (b- 160°C/1h; c- 160°C/12h; d-160°C/24h)

The X-ray diffraction analysis comes to complete the information about the phase nature of experimental specimens made of aluminum alloy type 7075, either cast or laminated T651 after applying various heat treatments. The results of X-ray diffraction analysis are shown in fig. 3a, fig. 3b.



a b

Fig.4- Difractometry analysis of experimental alloy in cast state and subsequently subjected to various aging treatments (a) and laminated and heat treated state (b)

Chapter 4 is entitled "Analysis of mechanical behaviour of experimental specimens of aluminium alloy type 7075". The chapter consists of two subchapters. In the first subchapter, entitled "Statistical evolution of the mechanical characteristics of aluminum alloy type 7075 in cast state, a complete statistical analysis is carried out on the mechanical characteristics of some batches of aluminum alloy type 7075, determining C_{PK} capability and P_{PK} performance indices. The results of statistical analysis on the mechanical characteristics of 7075 alloy sheets in the T651 state and different sheet thicknesses (30mm, 40mm, 50mm and 60mm, respectively) are presented comparatively in fig. 5, of which the following points are noted:

- The values of tensile strength decrease statistically as the thickness of the sheet increases. Thus, the highest value of mechanical strength of sheets is recorded at a thickness of 30mm, respectively 554 MPa, decreases to 549MPa for a thickness of 40mm, decreases to 545 MPa for a thickness of 50mm and reaches 539MPa for a thickness of 60mm. The total decrease of mechanical resistance values is 2.7%, obviously falling within the permissible deviations;
- a thickness of 30mm; 10.47% at a thickness of 40mm; 10.62% at a thickness of 50mm and 10.38% at a thickness of 60mm. The total decrease in elongation values is 2.25%;

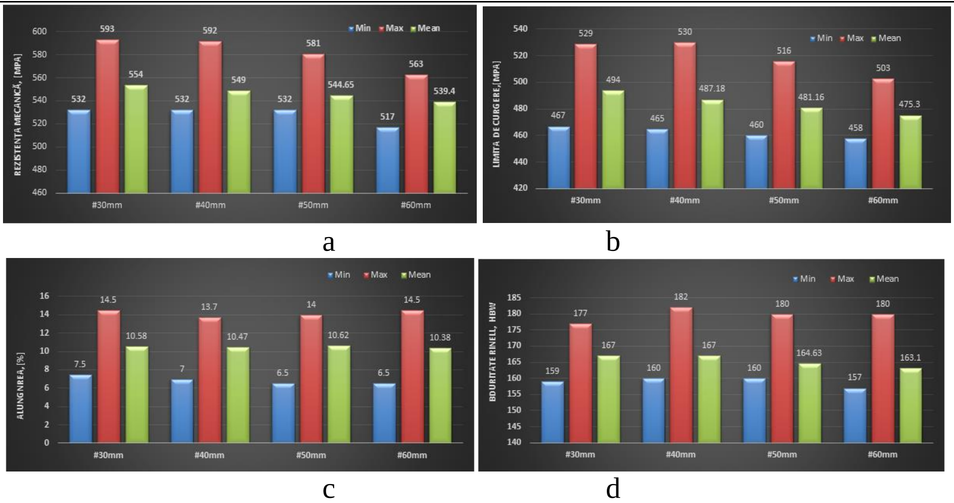


Fig. 5 Values of mechanical characteristics of products in 7075, after statistical processing (in state T651 and and different sheet thicknesses):a: mechanical strength, b- yield strength, c- elongation, d- HBW hardness

The detailed analysis of all data regarding the statistical behavior of the values of mechanical characteristics of 7075 alloy sheets in T651 state and different sheet thicknesses (30mm, 40mm, 50m, 60mm) shows that the considered processes are stable (in control) in the sense that all X and R values in the control sheets are within the control limits and there are no specific trends. The stability of a process is particularly important because a process that is stable today is likely to remain stable in the future unless major changes occur in its evolution. Thus, if a process is stable, its capability is likely to be predictable based on past performance.

- Analyzing the data from the perspective of CPK performance index values, it is noted that for all sheet thicknesses at elongation values this index is higher than 1.33, which means that the processes are stable with a normal distribution of values. As for the other mechanical characteristics, in few situations this index is above 1.33 (e.g. only yield strength values for 60mm thick sheets have a value of 1.38), otherwise these values are less than 1.33;
- P_{PK} capability index values are significantly lower than C_{PK}.
- The distribution of elongation values (at 60mm thickness) - with the value of the capability index P_{PK} 1.88 and with the value of the capability index P_{PK} 1.71 mm) indicates that this characteristic is in a state of statistical control (ie $P_{PK} \geq 1.67$ and Cpk$\geq$ 1.33).
- The fact that for the other characteristics the P_{PK} capability index value$\leq$ 1.67, and yet the process is stable, means that there must be process improvements through various corrective measures until continuous stability is achieved.

The complete statistical analysis performed on the values of mechanical characteristics of 7075 alloy sheets, in delivery condition (T651) and different thicknesses revealed that the applied technological processes led to obtaining appropriate mechanical characteristics, without deviations from tolerance limits, with high reproducibility and stability. At the same time, the additional use of CPK capability and PPK performance indices (fig.6) allowed a complete and reliable evaluation of the mechanical characterization of the performance of 7075 alloy products from ALRO Slatina production.

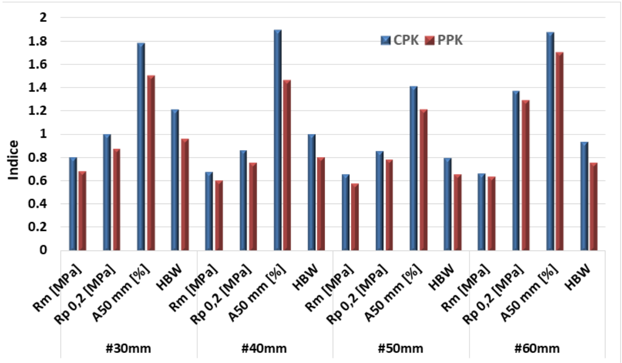
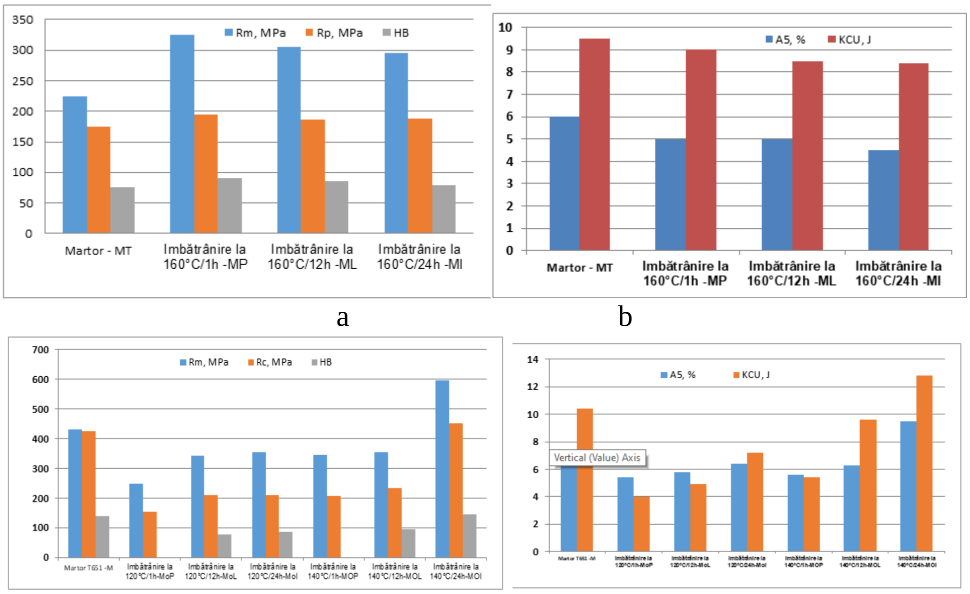


Fig. 6- Capability and performance index values for mechanical characteristics of products in 7075 after statistical processing (in T651 state and different sheet thicknesses)

In the second subchapter, entitled "Mechanical characteristics of samples of aluminum alloys type 7075 used in the experiments in this paper", experimental results were presented on the mechanical characteristics of specimens in different structural states of heat treatment, as illustrated in fig. 7.



a b

c d

Fig.7-

Histograms of mechanical characteristics of experimental specimens of alloy 7075,

a- mechanical strength, yield strength and hardness cast and aged at 160°C, different shelf life; b-elongation and resilience cast and aged at 160°C, different holding times; c- mechanical strength, yield strength and hardness in T651 laminate condition and aged at 120°C and 140°C, different holding times;

d- elongation and resilience in T651 laminate condition and aged at 120°C and 140°C, different holding times

Chapter 5 is entitled "Analysis of the behavior to cavitational erosion of experimental specimens of aluminum alloy type 7075". The chapter presents separately, for each structural state, the behavior to cavitational erosion, described using the diagrams of variation of the cumulative average depth - MDE(t) - and the related erosion rate - MDER (t). The results are complemented by stereomicroscope analysis, by measuring the areas affected by cavitation and the areas most affected by cavitation. At the end of the chapter, comparisons of expressive results are made, either by types of temperatures or by different shelf life in artificial aging.

Considering the behavior to artificial aging at 120°C, with different retention durations, the histogram in fig. 8, from which it is noted that this treatment does not increase resistance to cavitational erosion. The histogram of the comparison in fig.8, regardless of the parameter, shows that the structure of the delivery state (laminated blank) has the best resistance.

As of interest is the resistance of the structures conferred by the states obtained by volume heat treatment, we find:

- the weakest resistance is obtained by the one-hour treatment regimen (MoP condition) and the best for the 12-hour treatment (MoL state);
- the strengths of the structures obtained for the durations of one hour (MoP) and 24 hours (MoI) do not differ substantially (about 9% after MDEmax and about 8% after MDERs), practically being in the same category (with mediocre resistance to cyclic cavitation requests);

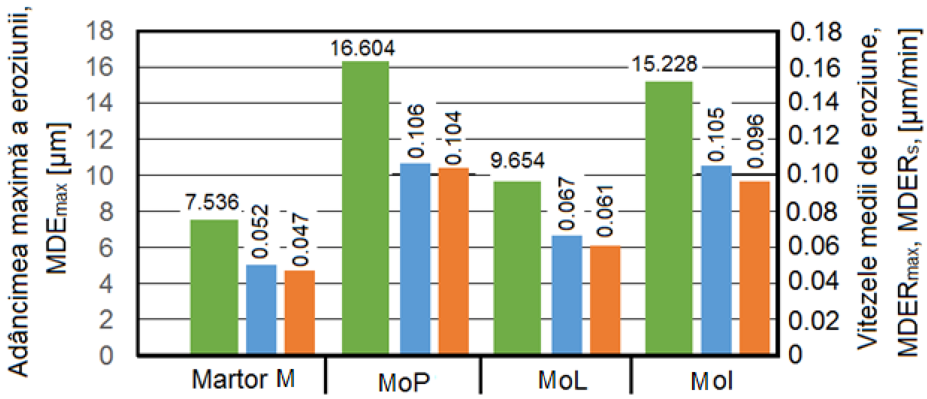


Fig. 8- Histogram comparing results on cavitational erosion behaviour of experimental specimens of 7075 alloy, laminate and heat treatment at 120°C, different holding times

The difference in strength of the MoL sample structure compared to the other two is seen in the differences between the reference parameters MDEmax and MDERs, as follows:

- the average cumulative depth of MDEmax compared to MoP is higher by about 72%, and compared to MoI is about 57%, insignificant
- compared to the values of MDERs erosion penetration rates, compared to MoP the decrease is over 70% and compared to MoI it is over 57%.

Considering the parameter referring to the area most affected by the cavitational attack, it can be noted the significant differences of the blank sample, with the smallest area affected, namely about 70%, compared to specimens aged at 120°C/1 hour, with an area of 82.3%, specimens aged at 120°C/12 hours, with an area of 81.8%, or specimens aged at 120°C/24 hours, with an area of 82.1%.

The histogram in fig.9 shows the differences between the values of the three parameters recommended by the ASTM G32 norms and used in the custom of the Research Laboratory for Cavitation Erosion Resistance, from U.P. Timisoara. The following findings can be made:

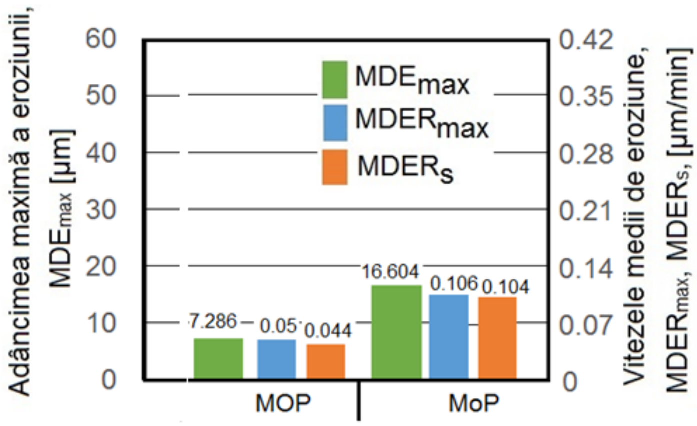


Fig. 9. Histogram comparing the results of the cavitational erosion behaviour of experimental specimens of 7075 alloy, laminate and heat treatment at 120 °C and 140 °C, one hour maintenance

- the weakest resistance is obtained by heat treatment regime with a temperature of 120 oC (sample M0P);
- comparatively, the average cumulative MDEmax depth recorded for the structure of the MOP sample, compared to that of the MoP sample, is more than 2.2 times smaller;
- compared to the values of the average penetration rates of erosion MDERs (whose inverse, Rcav = 1/ MDERs, represents the surface resistance to cavitation erosion) the strength of the MOP sample structure is over 2.3 times higher than that of the MoP sample.

The above findings show that in order to obtain a structure with properties that confer high resistance to cavitation erosion, through artificial aging heat treatment with a maintenance duration of one hour, a temperature of 140^{o}C is recommended.

If it is desired to compare the results regarding the resistance to cavitational erosion at 12 hours maintenance, either at 120 °C or 140 °C, the histogram shown in figure can be made. 10.

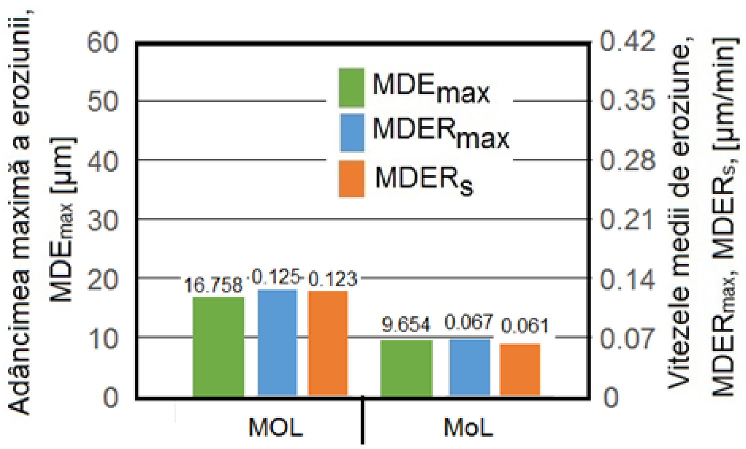


Fig. 10- Histogram comparing the results of the cavitational erosion behaviour of experimental specimens of 7075 alloy, laminate and heat treatment at 120 °C and 140 °C, maintained for 12 hours

The data from the histogram, shown in fig.10 lead to the following findings:

- - higher resistance to cavitation erosion is conferred by heat treatment at 120 °C;
- comparatively, the average cumulative MDEmax depth recorded for the MOL sample structure is almost 1. 7 times faster, and MDERmax speed is about 86% faster;
- compared to the values of the average penetration rates of MDERs erosion (whose inverse, Rcav = 1/ MDERs, represents the surface resistance to cavitation erosion) we find that the resistance of the MoL sample structure is about 2 times higher than that of the MOL sample.

The above findings show that in order to obtain a structure with properties that confer high resistance to cavitation erosion, by artificial aging heat treatment with a holding time of 12 hours, a temperature of 120 oC is recommended.

If it is desired to compare the results regarding the resistance to cavitational erosion at 24 hours maintenance, either at 120 °C or 140 °C, the histogram shown in figure can be made. 11.

The data from the histogram, shown in fig.11 lead to the following findings:

- of the two regimes the temperature of 1400C hours gives higher resistance;
- compared to the values of the average penetration rates of MDERs erosion (whose inverse, Rcav = 1/ MDERs, represents the surface resistance to cavitation erosion) we find that the resistance of the MOI sample structure is over 3 times higher than that of the MoI sample;
- by the value of the MDEmax parameter the strength of the MOI sample is about 2.5 times higher, and by the value of the MDERmax parameter is about 2.9 times.

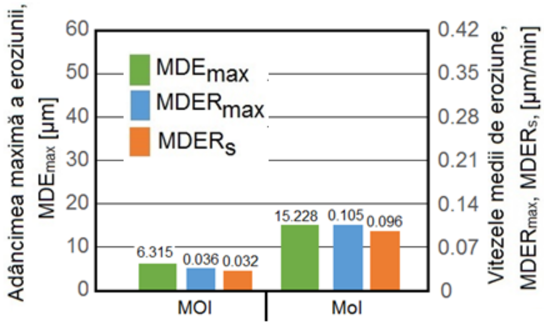


Fig. 11 Histogram comparing the results of the cavitational erosion behaviour of experimental specimens of 7075 alloy, laminate and heat treatment at 120°C and 140°C, maintained for 24 hours

Chapter 6 is entitled "Fractographic analysis of surfaces required for cavitational erosion of experimental specimens of aluminum alloy type 7075". A complete analysis of cavitationally eroded surfaces is performed under scanning electron microscope, highlighting the most significant aspects that could indicate the mechanism of rupture propagation through cavitational erosion. The fractographic analysis under the scanning electron microscope of the experimental specimens of aluminum alloy type 7075, in different structural states required at cavitation after 165 hours of immersion, highlighted the erosion of surfaces and is shown comparatively in fig.12 and fig.13.

- At low magnification power at SEM, i.e. at macrostructural observation of rough surfaces, covered with numerous cavities, regardless of the state of the superalloy. Differentiations can be made between the cast state, where there are tears of material, a sign of an extremely non-resistant behavior of the metal material to cavitational attack and the laminated state, where surfaces appear only rough. However, there is a slight intensification of the cavitational attack, within reasonable limits as the maintenance periods for artificial aging treatments increase;
- At higher magnification powers at SEM, i.e. at microstructural observation (fig.12 and fig.13), the cavitational attack appears similarly in all aluminum alloy specimens type 7075, in the sense of forming numerous cavities with complex geometries, a sign of a fragile behavior and poorly resistant to cavitational erosion. As the shelf life increases in various thermal treatments of artificial aging, there is a numerical increase in cavities, which tend to be uniformly arranged throughout the metal mass. There are, however, differentiations of fractographies according to the two structural states, namely cast and laminate. Thus:
    - o In molded specimens, massive tearing of material occurs, generating cavitations extended up to 1-3mm diameter; In cast and aged specimens the erosive attack is more intense than in the untreated specimen, but it still falls into the category of a material completely unresistant to cavitational erosion;

      o In laminated and aged specimens the fractographic appearance is less aggressive than in cast ones. The fractographic aspects are similar, with numerous fine faceted cavities and the presence of intermetallic compounds in the matrix.

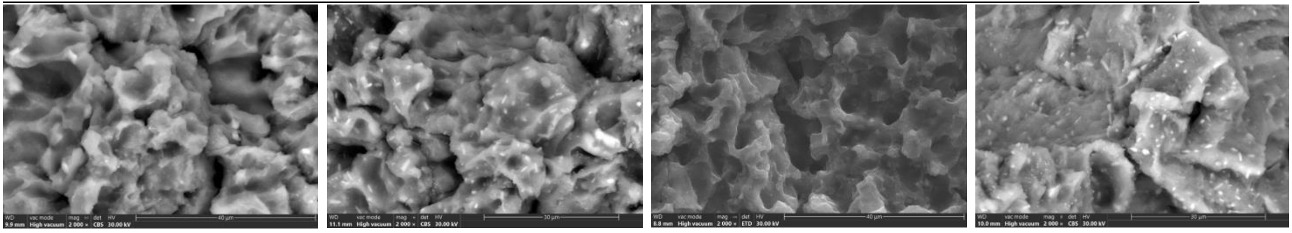


Fig.12- SEM analysis of experimental specimens of 7075 alloy experimental specimens in cast (a) and heat treated state at 160°C and different holding times: 1h (b); 12h (c), 24h (d)

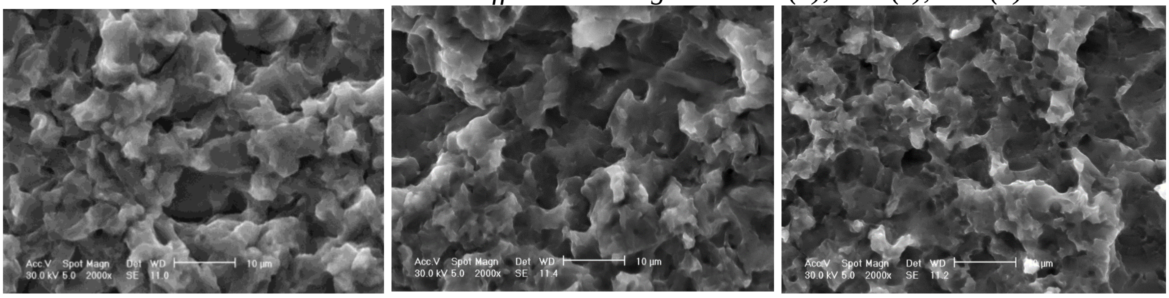


Fig. 13- SEM analysis of experimental specimens of 7075 alloy experimental specimens in T651 (a) laminated and heat treated state at 120°C/1h (b); and 140°C 1h (c)

CHAPTER 7 is entitled "CONCLUSIONS, ORIGINAL CONTRIBUTIONS, DIRECTIONS AND PERSPECTIVES OF FUTURE RESEARCH". The findings from the documentary research provide a comprehensive overview of the possibilities of precipitation hardening of Al-Zn-Mg-Cu alloys and its potential effects on the mechanical performance and corrosion resistance of these metallic materials. Consequently, the MgZn2 phase is the main precipitation phase that hardens 7xxx series aluminum alloys whose formation, distribution and geometric specifications are very sensitive to the parameters of aging heat treatment and how it is carried out. The conclusions regarding the own experimental research were grouped by types of experiments.

Conclusions on the structural analysis of experimental samples from aluminum alloy type 7075 revealed that the structure of aluminum alloy specimens type 7075, in cast state, consists of solid solution α and eutectic interdentritic, as well as two types of precipitates, respectively coarse interdentritic precipitates and finely distributed precipitates in matrix and intradendritic. The dendritic structure is accompanied by interdendtitic precipitation of the eutectic. Interdendritic precipitates are large (3-5µm), gray in color, almost with continuous precipitation. Qualitative phase analysis by X-ray diffraction revealed the polycrystalline nature of the analyzed samples. The crystallographic phases were identified according to the ICDD Release 2015 database: in cast specimens the $CuAl_2$ phase is found in the solid metal solution matrix α. The $CuAl_2$ phase does not significantly harden the metal matrix because it has a similar grid parameter, i.e. 84.2 nm, compared to 87.7 nm of the solid solution. In the cast state, the $CuAl_2$ phase dissolves and the metastable phase (i.e. $MgZn_2$) precipitates, whose diameter is much smaller compared to the crystal lattice (about 40% smaller). It is noted, however, that this parameter decreases as the aging duration increases, namely 42.7 nm (at 1h) to 37.1 nm (at 24h). In laminated products, the metal matrix of solid solution η has a network parameter of 74.5 nm, much lower than / t that of the cast state, respectively 87.4. The metastasic phase η′ (i.e. MgZ_n2) could not be identified, being in very small proportions. It is noted, however, that the network parameter changes significantly by applying various aging treatments, being in the range of 55.5 - 75.5nm.

Conclusions on the statistical analysis on the evolution of mechanical characteristics of sheets from 7075 showed that C_{PK} performance index values, for all sheet thicknesses at elongation values, this index is higher than 1.33, which means that the processes are stable with a normal distribution of values As for the other mechanical characteristics, in few situations this index is above 1.33 (e.g. only yield strength values for 60mm thick sheets have a value of 1.38), otherwise these values are less than 1.33. At the same time, the complete statistical analysis performed on the values of mechanical characteristics of alloy sheets 7075, in delivery condition (T651) and different thicknesses revealed that the applied technological processes led to obtaining appropriate mechanical characteristics, without deviations from tolerance limits, with great reproducibility and stability. The additional use of C_{PK} capability and P_{PK} performance indices allowed a complete and reliable evaluation of the mechanical characterization of the performance of 7075 alloy products from ALRO Slatina production. *Conclusions drawn from the analysis of the behavior to cavitational erosion of the specimens from 7075* showed that regardless of the parameters of the heat treatment regime, the structures of the samples taken from the cast semi-finished product have resistance to erosion of vibratory cavitation net before the structures obtained for the samples from the laminated semi-finished product, about 5 times after the values of the MDEmax parameter and about 5.9 times after the values of MDERs parameters; In all samples, whether blank or heat-treated, during the first 15 (30) minutes of vibratory cavitation, the erosion mechanism specific to it is observed, through which, in the attacked surface, more elasto-plastic deformations and crack networks are produced and roughness peaks and abrasive dust are eliminated. Expulsions of material with the creation of pittings are significantly reduced in the values of the masses recorded by weighing. For this reason, the surface appearance looks like a sanded/matted one; in all tests, from minute 105 (120) until the completion of the test, the losses are of a close order, which is why the MDE(t) curve is linearized, the differences between the experimental values of the speeds are small and the MDER(t) curve decreases asymptotically towards the MDERs stabilization value; in all samples, developments in MDER(t) averaging curves tend asymptotic towards maximum stabilization (MDERs). It can be concluded that this mode of evolution is the effect of mechanical properties, hardening over time, of the required layer and of diminishing the stress/impact force, as a result of the damping effect of air penetrated into the caverns formed; In relation to the strength of the semi-finished product structure (blank sample), depending on the temperature and the duration of maintaining the artificial aging heat treatment, the created structure can have resistance to the cyclic stresses of cavitation higher or lower, confirming the continuation of research in terms of using volume heat treatments to improve the cavitation resistance of aluminum alloy 7075. *The conclusions drawn from the fractographic analysis of the surfaces required for cavitational erosion of experimental specimens of alloy 7075* showed that at low magnification power at SEM, ie at macrostructural observation rough surfaces, covered with numerous cavitations, regardless of the state of the superalloy. Differentiations can be made between the cast state, where there are tears of material, a sign of an extremely non-resistant behavior of the metal material to cavitational attack and the laminated state, where surfaces appear only rough. However, there is a slight intensification of the cavitational attack, within reasonable limits as the maintenance periods for artificial aging treatments increase; at higher magnification powers at SEM, i.e. at microstructural observation, the cavitational attack appears similarly in all aluminum alloy specimens type 7075, in the sense of forming numerous cavities with complex geometries, a sign of a fragile behavior and poorly resistant to cavitational erosion. As the shelf life increases in various thermal treatments of artificial aging, there is a numerical increase in cavities, which tend to be uniformly arranged throughout the metal mass.

ORIGINAL CONTRIBUTIONS made by completing the present experimental researches are: carrying out a complete and complex structural analysis of experimental specimens made of aluminum alloy type 7075, in different structural states, either cast or rolled, followed by different thermal aging treatments, correlated with the assessment of resistance to cavitational erosion; realization of a complete statistical analysis performed on the values of mechanical characteristics of alloy sheets 7075, in delivery state (T651) and different thicknesses, which revealed that the applied technological processes led to obtaining appropriate mechanical characteristics, without deviations from tolerance limits, with high reproducibility and stability, cavitational erosion testing of aluminium alloy type 7075 in order to identify the propagation mechanism of cavitational breakage, as well as to identify the ageing heat treatment that can improve this behaviour; evaluation in an original manner of the surface condition of experimental specimens tested for cavitational erosion by simultaneous analysis under stereomicroscope, metallographic optical microscope and scanning electron microscope; consideration of a new parameter for assessing resistance to cavitational erosion, i.e. the area most affected by cavitational erosion. In this regard, a complete macrostructural quantitative analysis was performed under a stereomicroscope.

DIRECTIONS AND PERSPECTIVES OF FUTURE RESEARCH are expressed by the following directions and perspectives of future expressive research such as:

- The documentary research within the doctoral thesis identified some aspects regarding the complex possibilities of applying heat treatments specific to aluminum alloys of the 7xxx series, respectively the solution quenching followed by artificial aging, in one or more stages, which allow the improvement of the mechanical and operational characteristics of this class of metallic materials.
- Type 7075 aluminium alloys continue to be sources of future experimental research to explore their performance in the field of cavitational erosion in structural sensitisation states other than those used in the present experimental research.
- Experiments can be proposed and carried out in this directive regarding the use of stereomicroscopy specific techniques in assessing the condition of surfaces required for erosion - cavitational from different structural classes of metallic material.

LIST of PUBLICATED PAPERS

ISI web of knowledge papers

[1] Brandusa GHIBAN, Claudia NATRA, Alexandru CERNEA, Anca Daniela RAICIU, **Petrișor Ovidiu ODAGIU**, Irina BALKAN- STRUCTURAL INVESTIGATIONS CONCERNING Al 3003/Al 4xxx CLAD MATERIALS, U.P.B. Sci. Bull., Series B, Vol. 81, Iss. 4, 2019, ISSN 1454-2331

[2] Ilare BORDEASU, Brandusa GHIBAN, Vasile NAGY, Vlad PARAIANU, Cristian GHERA, Dionisie ISTRATE, Alin Mihai DEMIAN, **Petrisor - Ovidiu ODAGIU** - Cavitational erosion resistance considerations for alloy 6082 state T651 - U.P.B. Sci. Bull., Series B, Vol. 85, Iss. 1, 2023, ISSN 1454-2331

[3] Dionisie ISTRATE, Ilare Bordeasu, Brândusa Ghiban, Bogdan Istrate, Beatrice-Gabriela Sbarcea, Cristian Ghera, Alexandru Nicolae Luca, **Petrisor Ovidiu Odagiu**, Bogdan Florea, Dinu Gubencu. - Correlation between Mechanical Properties—Structural Characteristics and Cavitation Resistance of Rolled Aluminum Alloy Type 5083. Metals 2023, 13, 1067. https://doi.org/10.3390/met13061067

[4] **PETRISOR-OVIDIU ODAGIU,** CORNELIA LAURA SALCIANU, CRISTIAN GHERA , ANDREEA DANIELA BUZATU, LAVINIA MADALINA MICU, ALEXANDRU NICOLAE LUCA, ILARE BORDEASU, BRANDUSA GHIBAN - Heat Treatment Parameters Influence on the Cavitation Resistance of an Aluminum Alloy, U.P.B. Sci. Bull., Series …, Vol. …, Iss. …, 201 ISSN 1223-7027 (accepted, in publishing)

BDI Papers

1. Dionisie ISTRATE, Claudia Lazar (Natra), **Ovidiu Petrisor Odagiu**, Alin Mihai Demian, Andreea Daniela Buzatu, Brandusa Ghiban - Influence of homogenization and aging parameters applied to mechanical and structural characteristics of alloy 5083, IOP Conference Series, Materials Science and Engineering, vol. 1262, 2022, open access, 012021, DOI 10.1088/1757-899X/1262/1/012021
2. Claudia Lazar (Natra), Dionisie ISTRATE, **Ovidiu Petrisor Odagiu**, Alin Mihai Demian, Andreea Daniela Buzatu, Brandusa Ghiban- Evaluation of mechanical characteristics of 3003 aluminum alloy plated sheets, IOP Conference Series, Materials Science and Engineering, vol. 1262, 2022, open access, 012021, DOI 10.1088/1757-899X/1262/1/012021

Papers în cadrul unor conferințe naționale cu participare internațională

[1] Dionisie ISTRATE, Claudia Lazar (Natra), **Ovidiu Petrisor Odagiu**, Alin Mihai Demian, Andreea Daniela Buzatu, Brandusa Ghiban - Influence of homogenization and aging

parameters applied to mechanical and structural characteristics of alloy 5083, ACME-02-01: Materials and Surface Engineering, June 9th, 2022, ACME , Iași, code, 2-015

[2] Claudia Lazar (Natra), Dionisie ISTRATE, **Ovidiu Petrisor Odagiu**, Alin Mihai Demian, Andreea Daniela Buzatu, Brandusa Ghiban- Evaluation of mechanical characteristics of 3003 aluminum alloy plated sheets, ACME-02-01: Materials and Surface Engineering, June 9th, 2022, ACME, Iași, code, 2-016

[3] Dionisie ISTRATE, Alin Mihai DEMIAN, Andreea Daniela BUZATU, **Petrisor- Ovidiu ODAGIU**, Brândușa GHIBAN -The influence of heat treatments on the mechanical and structural characteristics of plastically deformed type 5083 aluminum alloys **-** 9th International Conference on Materials Science and Technologies – RoMAT 2022 November 24-25, 2022, Bucharest, Romania

[4] A. D. Buzatu, D. ISTRATE, A. M. Demian, **Petrișor - Ovidiu Odagiu**, B. Ghiban - Heat treatments influence on the mechanical behavior and structural characteristics of aluminum alloys type 2017 **-** 9th International Conference on Materials Science and Technologies – RoMAT 2022 November 24-25, 2022, Bucharest, Romania

[5] **Petrișor- Ovidiu ODAGIU**, D. ISTRATE, A. M. Demian, A. D. Buzatu, B. Ghiban-The influence of thermal treatments on the mechanical and structural characteristics of aluminum alloys type 6082- 9th International Conference on Materials Science and Technologies – RoMAT 2022 November 24-25, 2022, Bucharest, Romania

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