"Mircea cel Batran" Naval Academy Scientific Bulletin, Volume XVI – 2013 – Issue 1
Published by "Mircea cel Batran" Naval Academy Press, Constanta, Romania

STUDIES AND EXPERIMENTAL RESEARCHES ON PHYSICAL AND MECHANICAL PROPERTIES OF ALUMINUM ALLOYS

Mihaela SMEADĂ[1]
Maria STOICĂNESCU[2]
[1] Senior Lecturer Ph. D., "Henri Coandă" Air Force Academy, Brasov
[2] Senior Lecturer Ph.D. Eng., "Transilvania" University of Brasov

Abstract: *In the aerospace technique, the weight of the aircraft affects flight performance, so using the light and superlight alloys is extremely widespread. Improving the properties of these alloys is an extremely current requirement, which is justifying the researches*
Key words: *aluminum, heat treatment, hardness, microscopic analysis*.

1. INTRODUCTION

In the aerospace technique, the weight of the aircraft affects flight performance, so using the light and superlight alloys is extremely widespread. Improving the properties of these alloys is an extremely current requirement, which is justifying the researches.

Theoretical studies and experimental researches allowed both the study of the $ATSi_6Cu_4Mn$ alloy properties, of the heat treatments in improving the performance and also obtaining further information about the microstructures resulting from the heat treatments applied.

2. EXPERIMENTAL RESEARCHES

Samples coming from the same group of alloys, for which the concentrations were measured in the laboratory, were subject to artificial aging treatment following heating and direct quenching by keeping them in heated oil at 170 ° C for two hours while overlaying a stationary or variable magnetic field.

The influence of the magnetic field into artificial aging process is shown by the average values of the hardness determined from the measurements of the prints. The data obtained are illustrated in tables 1 and 2. It is noted that through the artificial aging by thermo-magnetic treatment (stationary magnetic field and variable magnetic field) the obtained average values of Brinell hardness are improved than the ones obtained by standard treatments (heat treatments).

Table 1. Prints and measured hardness after quenching and artificial aging while maintaining in stationary magnetic field for two hours [1,2]

Sample	Print [mm]	Hardness [HB]	
1	2,15	65,6	HB_{med}= 93,43
2.	1,70	107	
3	2,00	76	
4	1,64	115	
5	1,56	128	
6	2,09	69	

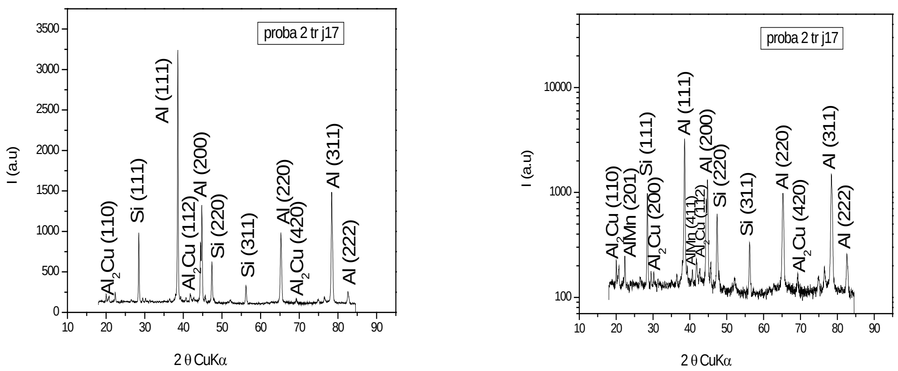
Changing the magnetic field, from stationary magnetic field to variable one, has determined the registration of the following values of prints and related Brinell hardness (table 2).

Table 2. Prints and hardness determined after quenching and artificial aging while maintaining in stationary magnetic field for two hours [1,2]

Sample	Print [mm]	Hardness [HB]	
1	1,6	121	HB= 103,83
2	1,67	111	
3	1,75	101	
4	1,74	102	
5	1,87	88	
6	1,76	100	

Prints and related hardness measured after two hours of keeping samples of aluminum alloy artificially aged into variable magnetic field are part of a much narrower range of values (88HB - 121HB) compared to values reported for the alloys maintained into stationary magnetic field (65.6 HB - 128HB). The experimental data recorded on the samples of aluminum alloy samples, artificially aged by thermo-magnetic treatment for two hours, indicates that applying variable magnetic field the average hardness increases compared to the value recorded by applying of a stationary magnetic field.

X-ray diffraction realized on sample 2 (*Si 6.172%, Cu 3.442%, Mn 0.555%, Al 89.26%*), thermo-magnetic treatment, cmv 2h and also SEM analysis on the sample had determined the registration of the images in figures 1 (a , b), 2 (a, b), 3 (a, b, c).



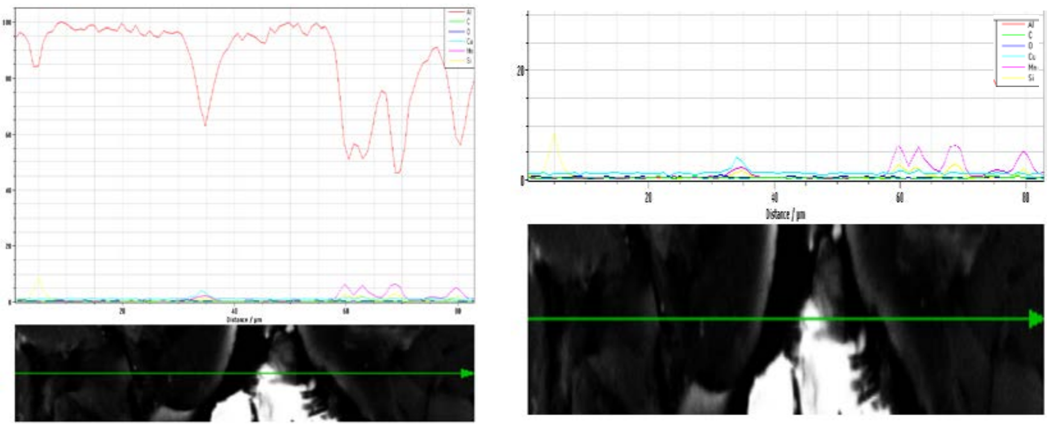
a) *b)*

Fig.1. The X-ray diffractogram (a, b)

Information obtained by X-ray diffraction for sample number 2 are, [1]:

- main phase has cubic structure, spatial group Fm-3m (225) aluminum (JCPDS 04-0787, network parameter a = 4.0494 Å);
- diffraction peaks of the main phase were Miller indexed according to this spatial group;
- network constant was calculated to be 4,042 Å;
- sample is textured on direction (311);
- crystallite size calculated by Scherrer formula is 70 nm.

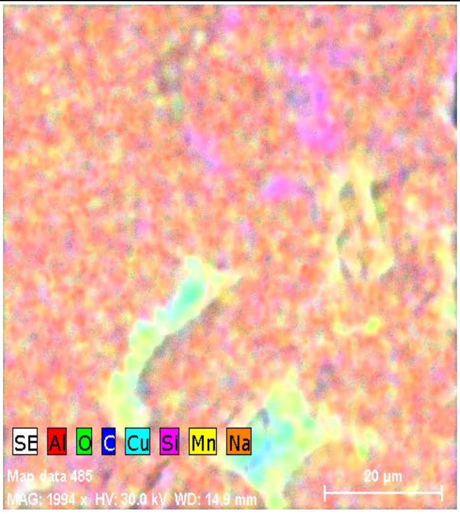
Qualitative analysis of studied samples demonstrates both the existence of such compounds as Al_2Cu and AlMn, and also preferred orientation on certain crystallographic directions. So preferential orientation is based on the following crystallographic directions: (111) and (311) for naturally aged alloy, (311) for artificially aged alloy by thermo-magnetic treatment applied for two hours. Scanning the sample 2 artificially aged by thermo-magnetic treatment applied for two hours, along a direction, gave information on the change of concentration of the various components along that direction (fig. 2a and fig. 2b).



a) b)

Fig.2(a.,b.) Linear scanning, ATSi$_6$Cu$_4$Mn alloy
(Si 6,172%; Cu 3,442%; Mn 0,555%; Al 89,26%), thermo-magnetic treatment, cmv 2h

The distribution of various chemical elements on selected areas of a sample artificial aged by thermo-magnetic treatment applied for two hours is shown in figures 3 (a, b).



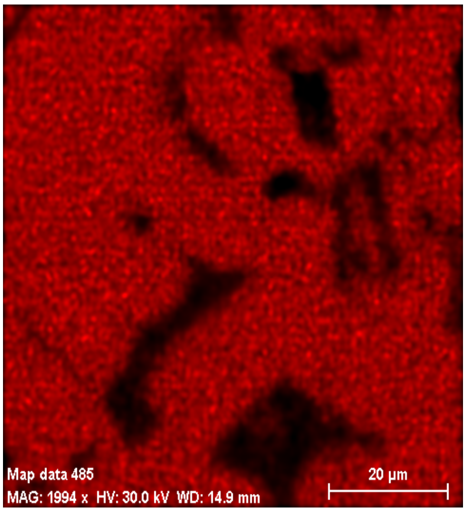
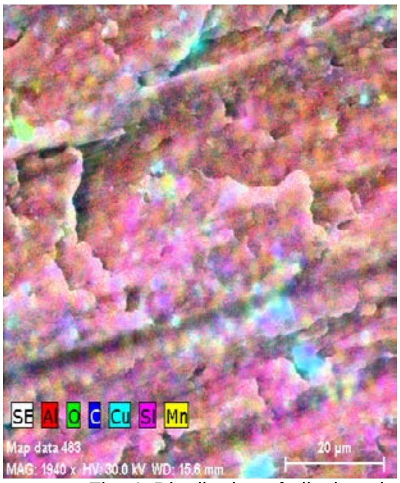


Fig.3a. Distribution of chemical elements   Fig.3b. Distribution of aluminum,

X-ray diffraction carried out on a sample which had not been aged, reveals only the existence of a main-phase of aluminum (fig. 4, 5).



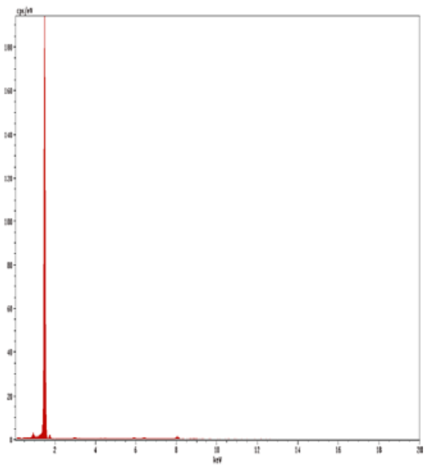


Fig. 4. Distribution of alloying elements,[1]   Fig.5. X-ray diffraction,[1]

For the same period of time (2 h) while applying thermal and thermo-magnetic treatments, the average hardness calculated presents an improved value if over the heat effect is overlapping a magnetic field, stationary or variable.(fig. 6).

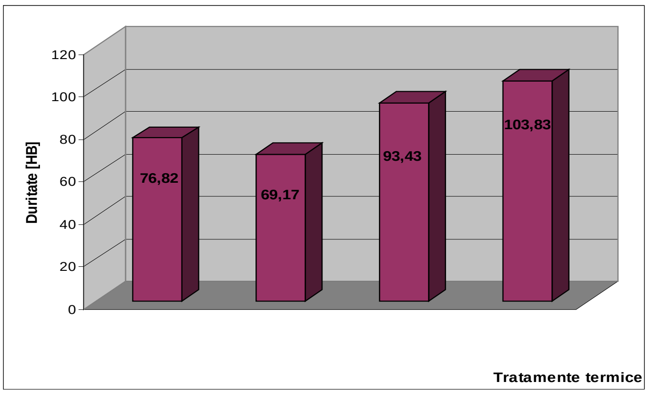


Fig.6. The average hardness by applying aging treatment, $ATSi_6Cu_4Mn$ alloy,[1]

The graphical representation shows the beneficial influence of thermo-magnetic treatment on medium values of hardness alloy studied, compared to the results achieved by natural and artificial aging.

3. CONCLUSIONS

The graphs shows the influence of the magnetic field on the mechanical characteristic studied; so after the application of the magnetic field (stationary or variable) the average value of the hardness is about 100HB.

Artificial aging treatments to which were subject the samples of $ATSi_6Cu_4Mn$ aluminum alloy, shows that can be achieved improved mechanical properties of aluminum alloys, the values recorded being interrelated with the type of heat treatment applied, the time of maintenance and the concentrations of the alloying elements.

Microscopic examination of the samples provided on one side information about the internal structure of the material, and on the other hand has allowed the determination of some important features of the studied alloy.

BIBLIOGRAPHY

1. SMEADĂ, M., (2011), *Studii şi cercetări privind îmbunătățirea proprietăților fizico-mecanice ale materialelor utilizate în tehnica aerospațială,* teză de doctorat, Universitatea Transilvania din Braşov
2. SMEADĂ, M., STOICĂNESCU, M., MUNTEANU, B., (2011), *Mechanical Properties of the Aluminum Alloys at Low Temperatures. Statitical Processing,* ModTech International Conference - New face of TCMR, May 25-27
3. STOICĂNESCU, M., (2005), *Studii şi cercetări privind tratamentele termice neconvenționale ale aliajelor pe bază de aluminiu*, teză de doctorat, Universitatea Transilvania din Braşov
4. STOICĂNESCU, M., SMEADĂ, M.(2009), *Experimental Research Regarding the Thermal Treatments Applied to Aluminium Alloys That Are Used in the Aviation Technique,* Metalurgia International, Editura Ştiințifică F.M.R.,NO.3
5. STOICĂNESCU, M., SMEADĂ, M., GIACOMELLI, I.,(2008) *Studies Concerning the Possibility of Hardening Through Thermic Isothermal Treatment of the Casting Alloys of Aluminum,* Analele Universității Ovidius Seria Inginerie Mecanică, vol. X, Nr.1