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THE INFLUENCE OF DIFFERENT AGING ON THE HARDNESS OF THE AA 7075

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Abstract. *The heat treatments applied in high performance aluminum alloys are essential to promote high mechanical strength to these materials. However, these heat treatments will cause an increase in costs, mainly due to the energy associated with the process, which will affect the final cost of the product. In these work, the AA 7075 was solubilized at 465 °C for 90 minutes and aged at room temperature, 90 °C and at 180 °C by 1h, 10h and 36 h. The samples were evaluated by Scanning Electron Microscopy/Back Scattered Electron Images (SEM/BSE). In addition were performed hardness tests. The results showed that the temperature and the time of heat treatment influenced directly the microstructure, properties and hardness of the alloy studied. The highest hardness value was found on the sample aged at 180 °C by 1 hour (85HRB). On the contrary, a lower hardness was found in the samples aged at 180 ºC by 36 hours (72 HRB), due to over-aging.*
Keywords: *AA 7075, Solubilisation Heat Treatment, Aging, Hardness.*

1. INTRODUCTION

The great versatility of the properties offered by the Aluminum Alloys families (AA), is associated with different chemical compositions. Due to its low density and excellent mechanical properties that can be obtained through thermal or mechanical treatments is extremely attractive for use in the air sector (Lima,2012).

The 7075T6 aluminium alloy is one of today's leading alloys. This type of alloy is the one that has the greatest resistance among all aluminium alloys, and can assume a value of 572 MPa, being greater than the resistance of some sweet steels. Due to this, this alloy is used in structures under high stresses, such as aeronautical, aerospace and defense accessories, such as gears and shafts, missile components, pressure regulators and switches (Alcoa,1991).

The heat treatments of AA alloys are based on the variation of the solubility of the microstructural elements present in its matrix. The solubilisation and aging control is achieved through the relationship between temperature and solubility of the phases present in the alloy (Weingaertner, 1991).

According to Weingaertner, (1991), the purpose of the precipitation hardening treatment is to perform a dense and fine dispersion of second phase particles, generating coherent precipitates with the ductile matrix. Thus, the mechanical strength of the alloy is increased through mechanical barriers generated by the precipitate particles, causing restrictions on the dislocations movement.

The heat treatments applied in high performance alloys are of great importance to impart a high mechanical resistance; however, they must be carried out in a suitable way to reduce the involved costs (Lourenço, 2014).

Considering these factors, it is interesting to study the influence of the parameters used in the solubilisation heat treatment and in the aging in the final properties of the material, seeking a greater efficiency of the process.

2. EXPERIMENTAL PROCEDURE

The 7075 aluminum alloy was solubilized at 465 ^{o}C for 90 minutes, cooled in water at room temperature and stored at low temperature to avoid natural aging. Differents groups of the samples were natural aged, by 1 h, 10 h e 36 h. The artificial agings were realized at 90 ^{o}C e 180^{o}C, in the same times, using a furnace JUNG, model LF00212 located at the Metallurgy and Materials Laboratory (UNIFEI - LMM).

The samples, in different conditions were metallography prepared and characterized by optical microscopy using a Zeiss optical microscope, Jenavert model and by Scanning Electron Microscope using a Carls Zeiss EVO MA15 model, located at the Estructural Characterization Laboratory of UNIFEI – LCE. X-Ray Energy Dispersion Spectroscopy (EDS) was used to determine the phase chemical compositions.

The hardness tests were performed hardness tests standardized by ASTM E18 -05e1 - Standard Test Method for Rockwell Hardness and Rockwell Hardness of Metallic Materials, Testor - Otto Wolpert-Werke, in at UNIFEI – LMM laboratory.

3. RESULTS AND DISCUSSION

3.1. ANALYSIS OF THE AS RECEIVED SAMPLE

The Fig. 1 and 2 show the micrograph and EDS analyzes of the as received sample. The zero (0) point indicates a Al-rich matrix, formed by the chemical elements of the alloy. The point 1 shows that the white regions are iron-rich intermetallic phases.

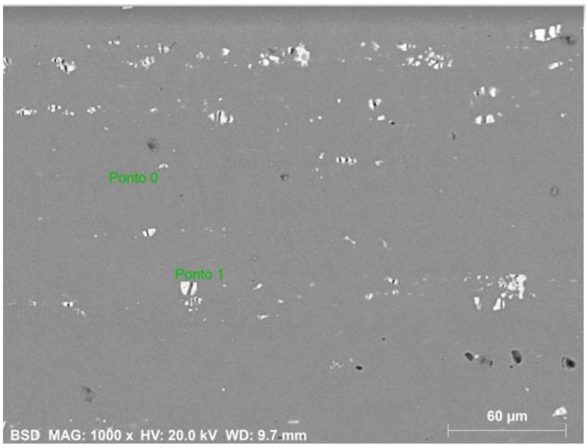
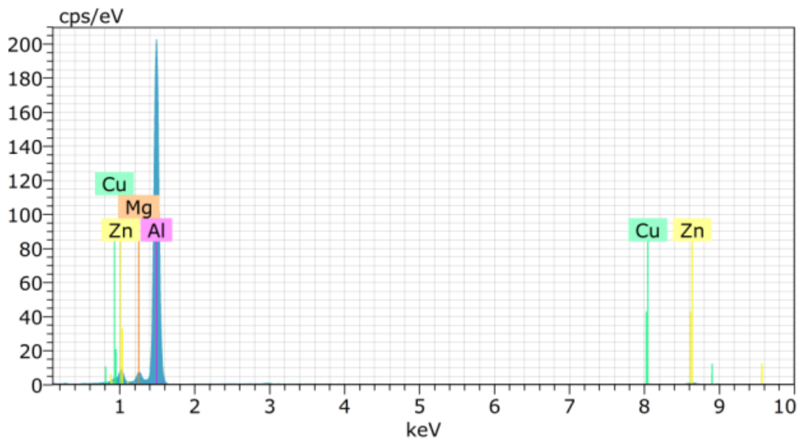
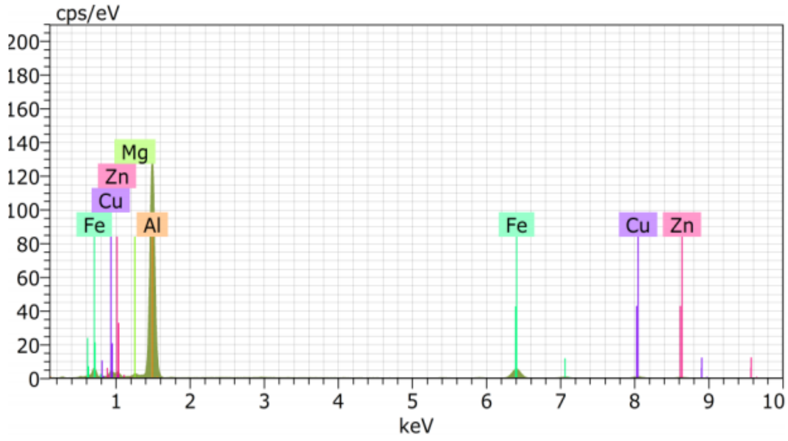


Figure 1: Micrography of the alloy in the as-received condition.



(a)



(b)

Figure 2: EDS spectra of the alloy in the as-received condition. (a) Point 0, matrix (b) Point 1, White region

The Fig. 3 show the elemental scanning of the AA 7075 in the as-received condition. By this analysis it was possible to identify the presence of two other intermetallic phases, a phase rich in Mg, and other rich in Cu, regions 1 and 2, respectively. These phases are classified as dispersoids because they are smaller than the constituent phases and are usually added for the hardening of material or used to decrease the solidification velocity.

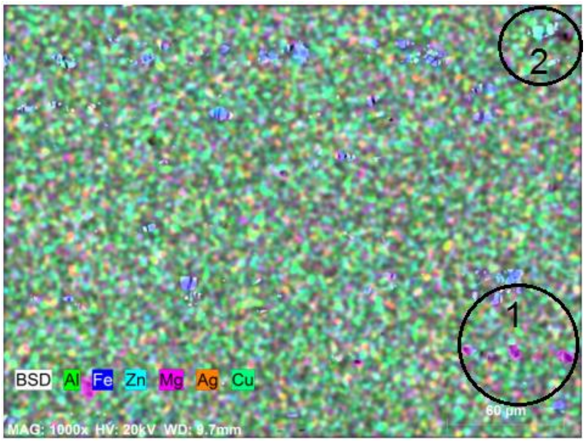


Figure 3: Analysis of total chemical composition by means of EDS.

3.2. NATURALLY AGED SAMPLES

The Fig. 4 show the micrography of the AA7075 alloy naturally aged by 1 h, 10 h and 36 h. With the optical microscopy analysis it was not possible to observe any change in the microstructure of the samples, as a function of aging time. Only the preferred orientation of the grains from the rolling process is observed.

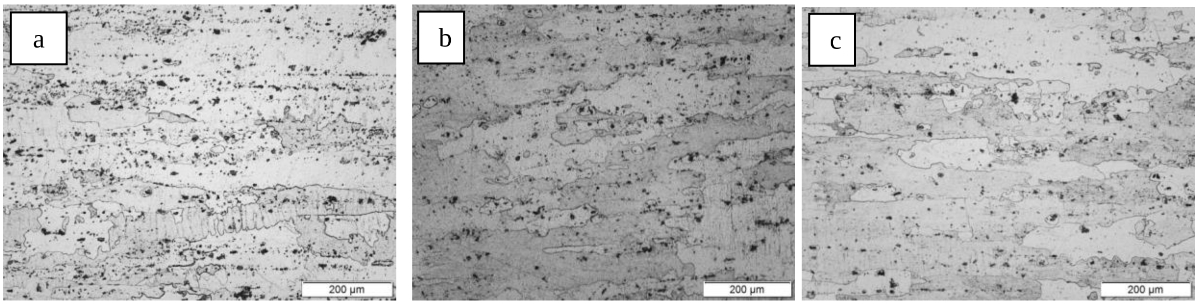


Figure 4: Micrography of the 7075 aluminum alloy naturally aged by 1 hour (a), 10 hours (b) and 36 hours (c).

3.3. ARTIFICIAL AGED SAMPLES AT 90ºC AND 180 OC

The figs. 5 and 6 shows that the artificial agings at 90 °C and 180 °C, changed the grains morphology, it is observed that with the increase of the aging time there was a significant reduction in the preferred grains orientation.

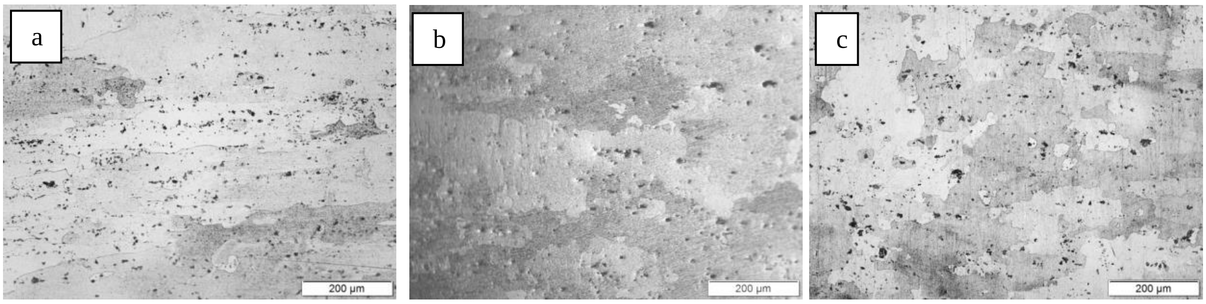


Figure 5: Micrography of the 7075 aluminum alloy at 90°C aged by 1 hour (a), 10 hours (b) and 36 hours (c).

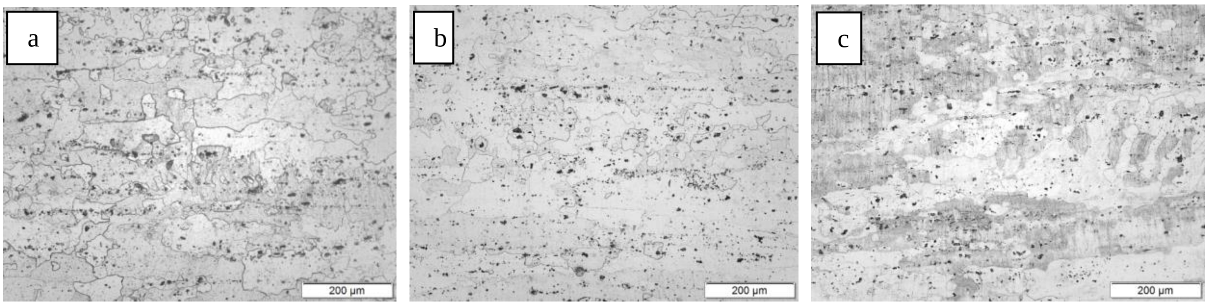


Figure 6: Micrography of the 7075 aluminum alloy at 180°C aged by 1 hour (a), 10 hours (b) and 36 hours (c).

It is known that with the aging treatment there is phase precipitation, however these phases can only be visualized by Transmission Electron Microscopy (TEM).

3.5 HARDNESS ANALYSIS

The curves shown in the graph of Fig. 7 show the hardness values of the naturally aged samples and artificially aged at 90 °C and 180 °C, samples.

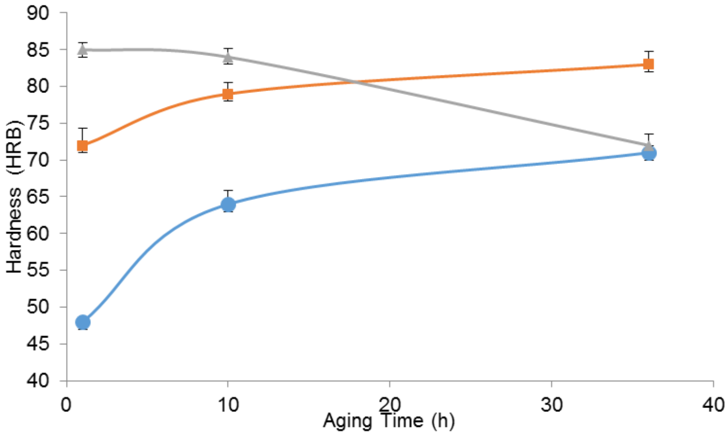


Figure 7: Hardness as a function of different aging condition for the 7075 aluminum alloy (● - room temperature; ■ – 90 °C and ▲ – 180 °C)

The results show that after one hour of aging it's observed that the hardness values increase with an aging temperature, increased in relation to the solubilized sample 45HRB. In the naturally aging the hardness values increase of the 47 HRB, to 64 HRB up to 66 HRB, for the aging at 1h, 10 h and 36 h, respectively. In the artificial aging at 90 °C, the hardness values increase of the 73 HRB, to 79 HRB up to 84 HRB, for the aging at 1h, 10 h and 36 h, respectively.

This hardness increase is related to higher phase precipitation as a function of temperature and treatment time. In the artificial aging at 180 °C, the hardness values decrease of the 85 HRB, to 79 HRB up to 72 HRB, for the aging at 1h, 10 h and 36 h, respectively. These decrease in the hardness values is related to the super-aging of this alloy.

4. CONCLUSIONS

The phases precipitation was not identified, because the TEM technique is required, however, the variation in the hardness values indicates the phases precipitation during the aging treatment.

The results showed that all the aging treatments were efficient for increasing the hardness of the AA 7075 alloy. The hardness of the samples naturally aged and those aging at 90 °C, increased with aging time. In addition, the hardness of the samples aged at 180 ° C were also higher, however, the hardness decreased with time due to super aging.

5. ACKNOWLEDGMENTS

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7. RESPONSIBILITY NOTICE