Influence of purity degree on the evolution the mechanical properties of aluminium commercial

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Abstract

The influence of the purity degree of the commercial aluminium on the mechanical properties: elastic stress, tensile strength, Brinell hardness, resilience and elongation at break was investigated. It was found that the first three resistance characteristics decrease with the growth of the purity of the material chosen to the detriment of two ductility characteristics that rise to the three states considered: crude of casting noted: F, Annealed noted: O, hardened noted : $H1/4$. Furthermore, it is important to note that the hardened and the annealed lead respectively to a considerable hardening and a considerable softening. This hardening and this softening of the material in question can be respectively associated with the increase in dislocation density and immigration impurity elements of dislocations.

Keywords: Purity, aluminum, properties, mechanical, hardness.
Themes: Mechanical and civil engineering applications.

1 Introduction

The natural aluminum does not exist. Indeed, although equal to 8% of elements on earth, man invented by extracting it from bauxite. The discovery of aluminum material with outstanding features: light weight, ductility, mechanical strength and weather, fastness, good thermal and electrical conductivities. These properties have quickly made aluminum one of the most magical materials used in the production of consumer goods of high and very high series with a tendency to consolidate its position as second only to steel. Extracted for the first time in the laboratory in 1825 and operated only industrially since 1880 after the discovery of electrolysis, aluminum has become in a century for its strength and lightness in in a wide range of applications on land, sea and air. This material has no harmful influence on environment both in production and in its recovery to its recyclability.

Aluminium and its alloys, and therefore will have a positive impact on quality of life for all of us.

Historically, the study of physical, chemical and mechanical in general especially the aluminum business and raises many questions of scientific interest and technological importance which did not leave indifferent to many researchers, since the use of this material is widely used in industry and in practice. It easily lends itself to shaping the cold plastic deformation (drawing, spinning, bending, cutting and boiler). He demonstrated excellent performance in a humid atmosphere and ocean.

Since the commercial aluminum enters the composition of many achievements and industrial applications, which are subject to various mechanical stresses, and in order to achieve a reliable product that must meet the proper functioning of the system to which it belongs, the properties this material mechanical saw multitudes of investigations and attracted the attention of many researchers. It was shown that the purity of the commercial aluminum significantly influences its mech anical properties.

In the literature, it was shown that the value of the yield strength of pure polycrystalline aluminum is about 4 times lower than that of the commercial aluminum.

Many authors have studied the mechanical properties of commercial aluminum with a purity of at least 99%. They lead to the following results: in the annealed condition, the majority of the mechanical properties are low, but they can be improved by cold working: for example, in the annealed condition hardened state, the yield increased from 28 to 125 MPa and the tensile strength varies from 70 to 130 MPa.

However, the results obtained by different authors are often conflicting and tight, if not contradictory.

Our job is to contribute to the effect of purity on the mechanical strength, Brinell hardness and resilience of the aluminum used in several commercial industrial achievements.

2 Material studied

The materials used are provided by the national ELECTRO - INDUSTRIES. There are three types of aluminum commercial purity (Al-99,0%, Al-99,5% Al-99,8%) who were selected to carry out this study.

3 Elaboration of the alloy studied

3.1 Casting:

The melting of the metal is in a gas oven production will switch from front to back, with a graphite crucible with a capacity 350Kg load is composed approximately ≈ 100% of aluminum ingots new commercial dimensions standardized composition and specified characteristics, delivered by the French company Pechiney. Once the mass has become liquid full at about 700° C. The liquid mass is then subjected to degassing treatment and coverage in the oven.

Then the metal is poured, or in a warm pocket of 50Kg prepared for this purpose for sand casting and series, or in a holding furnace of 150kg set properly for the unit shell mold preheated and that we proceed carefully prepared refining operations. Parts can be cast into the shell, respectively single metal or sand molds prepared for it, so the reference specimens are known as a crude of casting noting: F. To seek to increase over the characteristics of resistance to the state F, the two materials different degrees of purity will be subject to specific treatments of annealed and the hardened.

3.2 MOLDING:

METAL SHELL: In this mode of molding, the mold consists of two steel slabs (5% chromium), which is responsible for maintaining the footprints. These steel slabs, separated by a parting line, may be prepared and heated to a temperature $(200 \div 300)°$ C. After molding, the specimens cast metal shell by gravitation will be divided into three lots, each consisting of five identical tensile specimens , five specimens of resilience and a sample for the micrographic observation considering three states: a crude of casting notes: F, annealing noted: O and hardened noted: $H1/4$.

3.3 TREATMENTS OF:

- Annealing: heating and dissolved with homogenization at 540° C for 10 h followed by cooling in the oven,
- Hardening: deformation of 25% in 3 passes with a six-cylinder mill.

Once processing is done, the material will be tested in quasi-static uniaxial tensile loads and low speeds, Brinell hardness and quasi dynamic resilience to quantify the different characteristics of resistance and ductility needed for different calculations which we need the design engineer at the department. The microstructure complement the study to fully identify the material.

4 EXPERIMENTAL PROCEDURE:

To determine the behavior of the material meet the different demands it may encounter during use, these solicitations are reproduced using static or dynamic tests, usually performed on standard specimens to determine the characteristics encrypted material. Four techniques are used, namely: the pull to identify the various constraints, the Brinell hardness HB for the stress field, Kcv resilience tells us about the mode of fracture, fragility and the impact resistance and metallography to identify structures. We will describe in more detail and present in the main mechanical characteristics of the material being obtained in this study.

5 RESULTS OBTAINED AND DISCUSSION

The average values of mechanical strength, impact strength and hardness of the three states of the aluminum commercial are those given by averaging five identical specimens for each of the respective cases and are represented by the figures of 1 to 5 mentioned below.

5.1 Influence of purity degree on the evolution the caracteristics of resistance of the three states of the commercial aluminum

DISCUSSION: For the three states considered in choosing commercial aluminum, we followed the evolution of variations of the three main features of resistance: average stress of elasticity noted $< \sigma e >$, maximum average stress noted $< \sigma m >$ and Brinell hardness average noted $< HB >$ depending in the purity of the material studied.

Figures 1, 2 and 3 show that the average curves of the three mechanical characteristics of resistance of the three states considered to decrease with the growth of the purity at the expense of ductility, however, the speed of decrease varies differently depending on the mechanical characteristic and the state considered.

We also note that the average curves of the three characteristics of resistance of the hardened state are located too far above those of the annealed condition, which are themselves just above those of the as-cast state.

5.2 Influence of purity degree on the evolution the caracteristics of ductility of the three states of the commercial aluminum

DISCUSSION: The same for the three states considered in choosing commercial aluminum, we have also followed the evolution of variations of two main features of ductility:

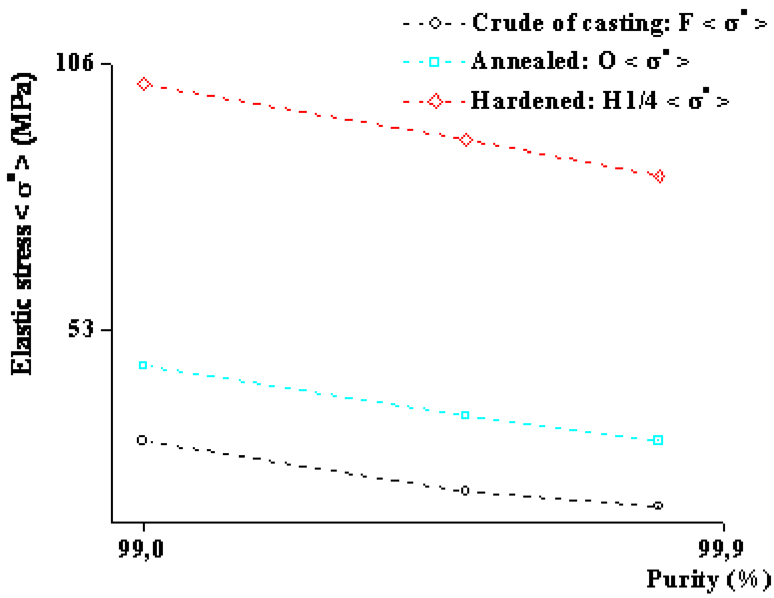

Figure 1: Group of graphs (average stress of elasticity – purity degree) of comparison in averaging a series of five identical specimens of the aluminum commercial of the three states: crude of casting noted: F, annealing noted: O and hardened noted: $H1/4$.

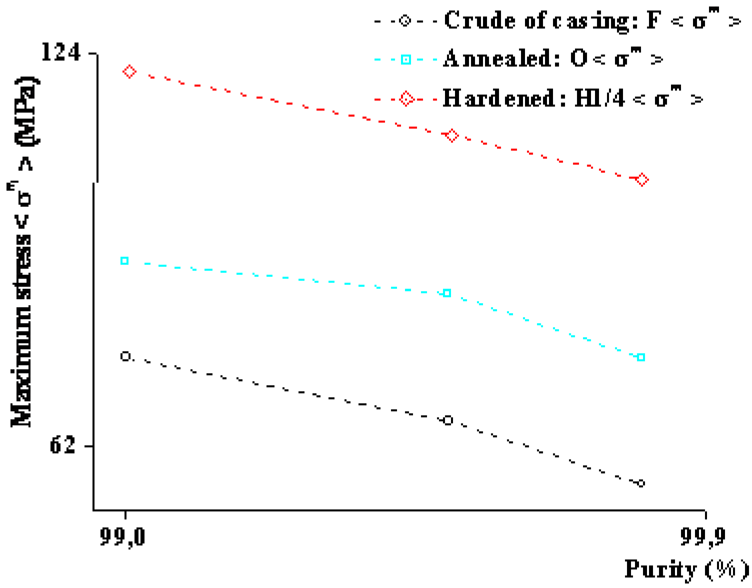

Figure 2: Group of graphs (maximum average stress – purity degree) of comparison in averaging a series of five identical specimens of the aluminum commercial of the three states: crude of casting noted: F, annealing noted: O and hardened noted: $H1/4$.

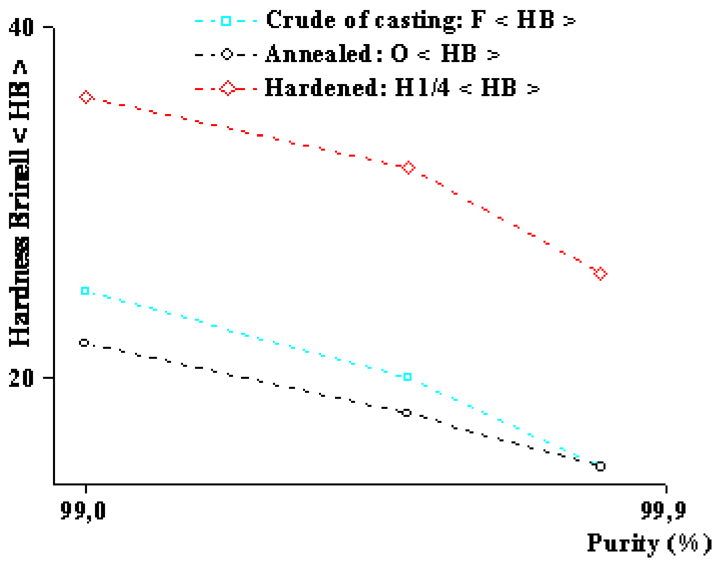

Figure 3: Group of graphs (hardness Brinell HB average – purity degree) of comparison in averaging a series of five identical specimens of the aluminum commercial of the three states: crude of casting noted: F, annealing noted: O and hardened noted: $H1/4$.

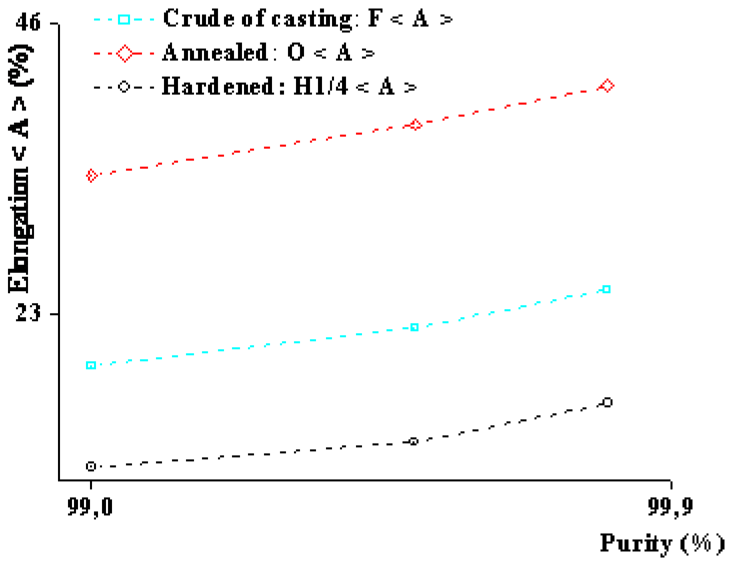

Figure 4: Group of graphs (average elongation A% – purity degree) of comparison in averaging a series of five identical specimens of the aluminum commercial of the three states: crude of casting noted: F, annealing noted: O and hardened noted: $H1/4$.

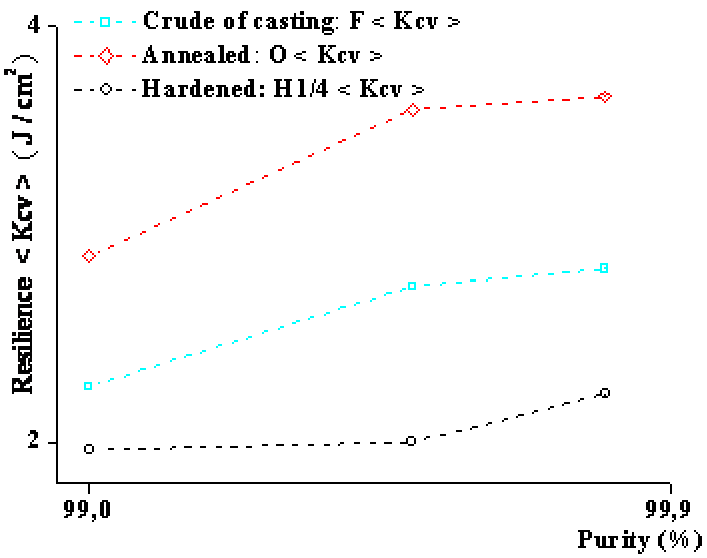

Figure 5: Group of graphs (average resilience Kcv – purity degree) of comparison in averaging a series of five identical specimens of the aluminum commercial of the three states: crude of casting noted: F, annealing noted: O and hardened noted: $H1/4$.

average resilience designated $< \text{Kcv} >$ and average elongation designated $< \text{A}\% >$ depending on the purity of the material studied.

Figures 4 and 5 show that the average curves of the two mechanical characteristics of ductility of the three states considered to grow with the growth of the purity at the expense of resistance characteristics , however, the growth speed varies differently depending on the mechanical characteristic and the state considered.

We also note that the average curves of the two characteristics of ductility of the annealed state are located too far above those of the as-cast state, which are themselves just above those of the hardened state.

CONCLUSION: In this study the mechanical properties of tensile, Brinell hardness and resilience of the aluminum commercial, we have shown that the strain hardening delays the onset of the movement of dislocations, but accelerates the process of rupture and also leads to a considerable hardening and a drop of plasticity simultaneously. In the annealed condition, the material hardens, but the hardening is lower to that of the material in the hardened state. In addition, during this annealing is a great plasticity of the material. The poor mechanical properties of the material in the as-cast state be associated with the presence of heterogeneities. The increase in purity leads to softening of the material.

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