Influence of the treatment parameters on the evolution the properties of the elasticity, plasticity and structural of polycrystalline alloy 43300

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Abstract

The purpose of this study is to determine the influence of the parameters of treatments on the evolution of the behavior and the damage in tension, the Brinell hardness, the microhardness, the resilience and the microstructure of the alloy of chemical designation AlSi10Mg and numerical 43300 considering three states of the material: crude of casting noted: F, tempered noted: T and matured followed by an artificial aging designated T46. The addition of 10% silicon which gives excellent casting ability and a percentage of magnesium ($\leq$ 1% Mg) to aluminum are the main agents for improving the mechanical properties in addition to specific thermal treatments which reveal precipitates of different kinds which hinder the movement of dislocations. We studied the influence of structural hardening, Mg addition and casting method: sand and shell metal on the elasticity and plasticity characteristics of the polycrystalline Al-10% alloy. This alloy supports mean mechanical stresses. Parts made from this alloy are part of the components and realizations of the SNVI (Unit Aluminum of Rouiba) and Electro-Industries (Unit Freha Motors in Tizi-Ouzou), Algeria.

keywords: Al - Si, sand, shell, tempered, tempering, mechanical properties..

1 Introduction

In this study we are interested in the mechanical properties of the alloy hypoeutectic Al - 10% mass. If for five different states (crude of casting noted: F, tempered condition noted: T, ripened noted: M12h). The three states are respectively matured each followed by tempering noted: T46. Measurements of the characteristics of strength and ductility were determined, respectively, at room temperature, using the traditional method of uniaxial tension. The analysis shows that maturation leads to changes in mechanical characteristics: rise and decline of the respective elastic and plastic characteristics. The observed variations are associated with the evolution of the microstructure: the presence of heterogeneities in the as-cast, removing the last during the homogenization and reduction of internal stress during maturation of the material. The choice of this material was dictated by the fact that it is very much used in various mechanicalBrʹapplications; while the addition of 10% silicon, $(0,17-0,40)\%$ Mg and ofBrʹits heat treatment associated with the various industrial processes of molding of sandBrʹand shell were selected following the considerable improvements of certain required properties of which silicon gives him excellent aptitudes forBrʹcasting combined withBrʹmagnesium which is the principal agent of improvement of the mechanical characteristics [112].

2 Studied material

BrʹThe material used isBrʹa nuance containing a littleBrʹmagnesium added in small quantity $(0,17$ to $0,40)\%$ Mg toBrʹalloyBrʹto allow the hardening Brʹand for a rational use in applications toBrʹhigh mechanical characteristics withBrʹthe T46 state. This alloy contains silicon 10% which confers to him very good properties of implementation in foundry (average flow, weak volumetric contraction withBrʹsolidification, reduction in the withdrawal inBrʹa solid state and dilation coefficient.). It is used for complex piece, withBrʹrequirements for average mechanical behaviors and of which the thicknesses are very low (≈ 5 mm).

3 Elaboration of the alloy studies

3.1 The casting

The fusion of metal is done in an oven with gas of production tipping the forward backward comprising a graphite crucible of capacity 350Kg of which charge is composed approximately $\approx 40\%$ of new bars in dimensions standard of composition and characteristics AlSi10Mg although determined., delivered by the French Pechiney company and a mixture of casting jets $\approx 60\%$ return (appendages of feeding, evacuation and regulation, parts defective and rejected). The parts can be respectively cast in the single metal shell or of the sand moulds prepared for this purpose, thus the test-tubes of reference are called crude of casting noted: F To seek to increase more the characteristics of resistances of the state F and to obtain essentially big constraints of elasticity, big modules of rigidity with low deformations, and the material of digital name 43300 is subjected to the noted specific treatments: T46.

3.2 Molding

1. Sand: this casting is composed of two half fingerprints left by the model in the packed sand.

2. Shell: in this method of casting, the mould is composed of two floor screeds (5% of chromium), which has the role to keep the fingerprints. These floor screeds, separated by a joint plan, must be eventually prepared and heated to a temperature $(200\text{div}\,300)^{\circ}$ C After analysis, the test pieces cast in sand and metal shell by gravity have the following chemical composition.

Chemical elements	Si	Mg	Fe
% According to analysis	9,62	0,34	0,15

Results of the chemical analysis after control on test-pieces cast in sand and shell.

This alloy is manufactured by two different methods: casting sand and casting shell considering 03 States rated respectively; crude of casting: F, tempered: T and tempering: T46.

4 Experimental procedure

The physical characterization, chemical and mechanical in general especially crucial importance for the design of various metal parts subjected to external forces varied constituents various mechanisms in motion a mechanical component. The designer can therefore neither calculate nor size these parts without identifying and quantifying their characteristics. To determine them, we reproduce these loads using static or dynamic tests, usually performed on standard specimens. Four techniques are used, namely traction to identify the various constraints, the Brinell hardness HB for the stress field, Kcv resilience tells us about the mode of fracture, brittleness and impact resistance and metallographic shows the structures. We will describe in more detail and present in the main mechanical characteristics obtained from the chemical composition of material being AlSi10Mg purpose of this study

5 Results obtained and discussion

The average values вЃЌвЃЌof tensile mechanical properties, resilience and hardness of the alloy AlSi10Mg are those given by averaging five identical specimens for each of the respective cases and are represented in Figures 1 to 3 below.
Influence of molding processes in the sand and in the shell for alloy AlSi10Mg on the characteristics in:

5.1 resistances

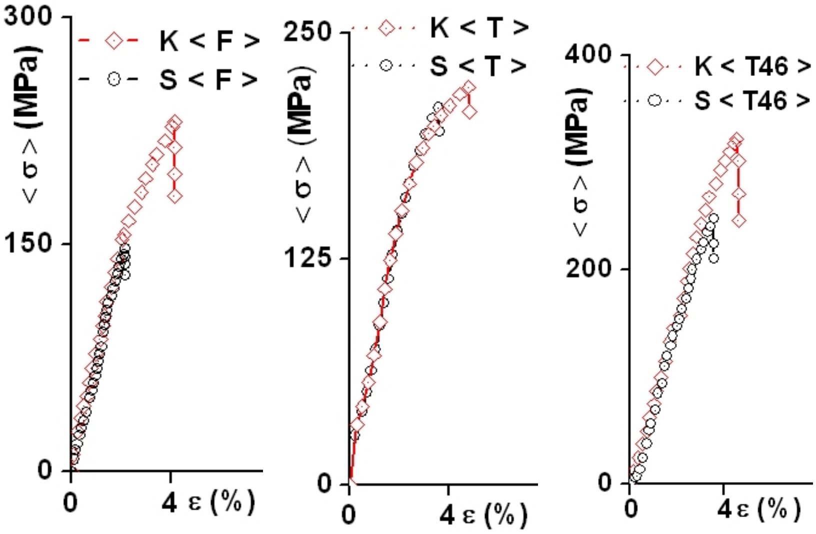

Figure.1 вЃY Grouping of the mean curves of comparison (mean stress - deformation) of the AlSi10Mg alloy casted in sand and in shell: $a - K < F > \diagup S < F >, b - K < T > \diagup S < T >$ and $c - K < T46 > \diagup S < T46 >$.

Notation: F - Crude of casting, T - tempered, T46 - tempering, S вЃY sand, K - shell, Ox (%) - deformation (%) and $< \sigma >$ (MPa) - stress (Mega Pascal).

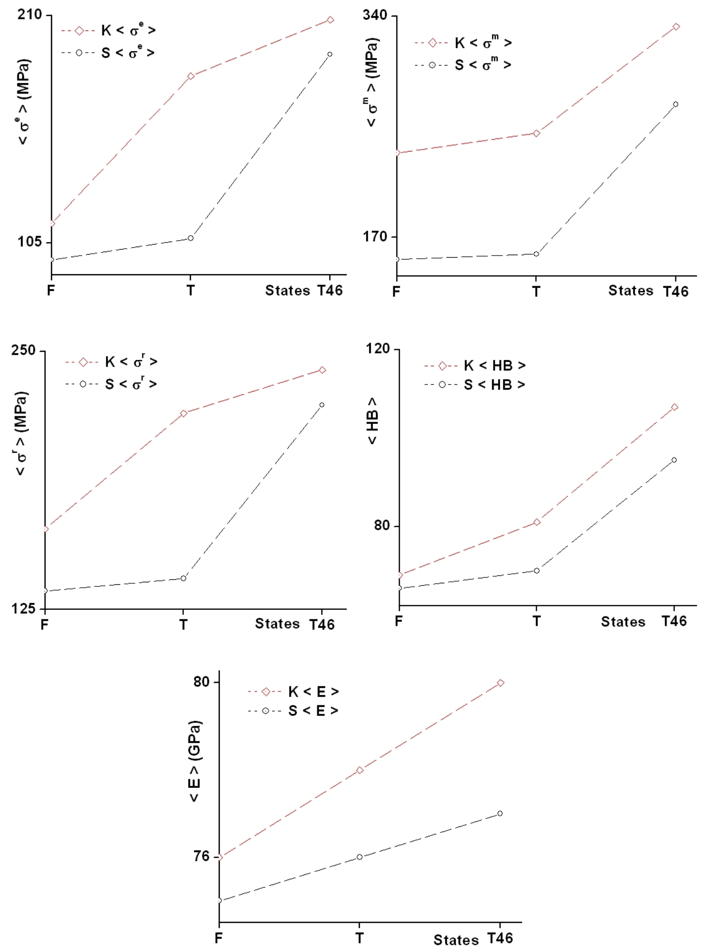

Figure.2 вЃY Grouping of the mean Graphs of comparison (mean stress, mean hardness and mean Young's modulus - states) of the AlSi10Mg alloy casted in sand and in shell: $a - K < \sigma e > /S < \sigma e >, b - K < \sigma m > /S < \sigma m >, c - K < \sigma r > /S < \sigma r >, d - K < HB > /S < HB >$ and $e - K < E > /S < E >$.

Discussion. It is seen that all curves and all the graphs of the shell casting are above those of the sand casting whatever of the states considered. In addition to the increase in mean values вЃKвЃKof the characteristics of resistance is the state F to the T state, reaching its maximum value to the state T46 whatever the two modes of elaboration at the expense of ductility; This is probably due on the one hand, the mode for cooling the molds, on the other hand the addition of alloying elements combined with structural hardening treatment by precipitation.

5.2 Ductility

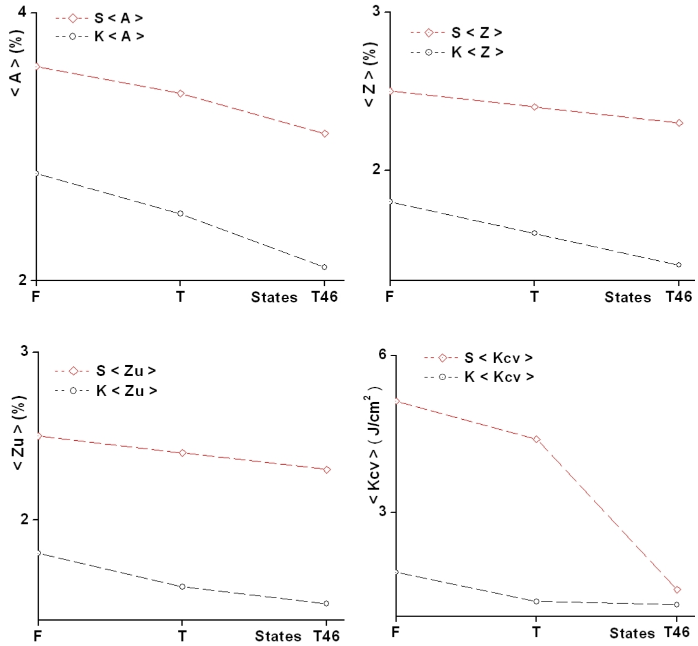

Figure.3 - Grouping of the mean Graphs of comparison (elongation, coefficient of necking, elongation of necking and resilience-states) of the AlSi10Mg alloy casted in sand and in shell: a-K $< A\% > /S < A\% >, bK < Z\% > /S < Z\% >, c - K < Zu\% > /S < Zu\% >$ and $d - K < Kcv > /S < Kcv >$.

Discussion We see that all curves of sand casting are above those of the shell casting whatever of the states considered. In addition to the increase in mean values of ductility characteristics is the state T46 that of T to reach its maximum value at state F regardless of the two modes of elaboration to the detriment of the characteristics of resistance.

Notation: $< \sigma m >$ (MPa) - mean maximum stress (Mega Pascal) ,$< \sigma e >$ (MPa) - mean elastic stress (Mega Pascal), $< \sigma r >$ (MPa) - mean breaking stress (Mega Pascal),$< HB >$ - mean hardness Brinell HB,$< E >$(GPa) - mean Young's modulus (Giga Pascal), $< A\% >$ - mean elongation (%), $< Z\% >$ - mean coefficient of necking, $< Zu\% >$ - mean elongation of necking, F - crude of casting, T - Bŕtem-pered, T46 вЃY tempering, - Sand and K-shell.

6 Influence of hardening on the evolution of mechanical properties of the alloy AlSi10Mg mode casting

Discussion in molding processes in the

6.1 Sand

The average curve of the sand casting to the S $< T46 >$ state is in top of the other curves i.e. those of the stateвЃЄs S $< T >$ and S$< F >$. The constraints, hardness HB and the coefficient of rigidity means increase with a clear improvement of state S $< F >$ to the state S $< T >$ by reaching the maximum values with state S $< T46 >$ to the detriment of the characteristics of ductility which decrease in opposite direction. On the other hand the coefficient of consolidation and Poisson's ratios remain almost invariants for the sand casting.

6.2 Shell

In the same way the average curve of the shell casting to the K $< T46 >$ state is in top of the other curves i.e. those of the stateвЃЄs K$< T >$ and K$< F >$. The constraints, hardness HB and the coefficient of rigidity means increase with a clear improvement of state K $< F >$ to the state K $< T >$ by reaching the maximum values with state K $< T46 >$ to the detriment of the characteristics of ductility which decrease in opposite direction. On the other hand the coefficient of consolidation and Poisson's ratios remain almost invariants for the shell casting.

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