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DAMAGE AND BEHAVIOR OF AlSi7ZnMg ALLOY IN TRACTION AND SHOCK

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This study deals with the influence of structural hardening on the evolution of the resistance, ductility, and microstructural characteristics of the polycrystalline alloy AlSi7ZnMg casted in sand and metallic shell by gravitational casting at ambient temperature, both mechanical and manual of metal parts for the different realizations of the Foundry Aluminum Unit of Rouïba, Algeria.

The main objective is to determine the processing parameters that should result in the higher structural level of cure and an adequate structure of the alloy. For this, we proceeded to the application of a heat treatment cycle: heating with dissolution and homogenization followed immediately by quenching in water at room temperature, matured and tempered at temperatures and well-defined time.

To obtain high levels of mechanical resistance, it is necessary to impede the movement of dislocations throughout the mass of the alloy by causing refining the grain size and formation of finely dispersed precipitates ($MgZn_2$, Mg_2Si, Si, Zn, and Mg); for that we put him through a structural hardening done in four stages.

The different results obtained during the investigation, show a significant increase in strength characteristics with a compromise ductility. The different investigative techniques have achieved the objective study using hardening experiment of the alloy.

Keywords: Al-Si, tempering, curing, income, sand, shell.

1. Introduction

Physical, chemical and in particular mechanical characterization is of paramount importance for the dimensioning of metal parts subjected to external forces resulting from moving mechanisms. The designer can therefore neither calculate nor design these parts without identifying and quantifying their characteristics. To determine them, we reproduce these loads with static or dynamic tests usually performed on standard specimens.

AlSi7ZnMg, which is the subject of our study, is an alloy containing zinc and magnesium added in a little quantities ≤1% Zn and ≤1% Mg to allow structural curing, as well as for rational use in applications with high mechanical

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characteristics in the T46 state. This alloy contains 7% silicon, which gives it good casting properties, used for parts with complex shapes, in very good mechanical requirements and whose thickness can locally down below 10 mm [1 - 13].

The unalloyed aluminum with very reduced mechanical properties, lead to add two elements of very low density which 7% silicon and traces of magnesium less than 1% which is the lightest of all metals which stable industrial employment to improve its properties and thereby obtain a light AlSi7ZnMg alloy.

Mechanical properties are closely linked to the microstructure. To understand the behavior of materials in use and in order to control their properties, it is necessary to describe and quantify their microstructure.

This material is recommended by the fact that it is widely used in various mechanical applications. The addition of 7% mass Si, (0,10 ÷ 0,70)% mass Zn and Mg to aluminum, and its specific heat treatments which show precipitates of different kinds that block dislocation motion associated with industrial processes sand casting and metal shell were selected in order to improve significantly some desired properties. Si gives excellent skills casting, Zn increases the resistance to corrosion and oxidation and Mg main agent for improving mechanical properties, which allows structural hardening.

The additions elements go into solution and may be present in the form of intermetallic phases. The composition of these phases, but especially their fineness, distribution, consistency with the aluminum matrix, their intrinsic fragility, stability as a function of heat treatments are also decisive for the properties of the alloy [6 - 13].

2. Description of the issue

To improve the poor characteristics of industrial aluminum three elements are deliberately added (7% Si, Zn and Mg ≤ 1%) in the Al matrix in addition to specific thermal treatments that show different types of precipitates, which interfere the movement of dislocations. The four elements forming the alloy are recyclable, low density and are abundant in nature. These three advantages make aluminum and its alloys the most coveted by the aerospace, road, rail, naval and all kinds of construction industries, because the major concerns of designers in these industries are easing, economy, ease of handling, improved reliability and safety of different structures.

Our objective is to contribute to the study of the mechanical properties of tensile strength, hardness, micro-hardness, resilience and structural of AlSi7ZnMg foundry alloy used in sand casting and metal shell metal flows by gravity parts and for the various embodiments of the SNVI (Aluminum Foundry Unit, Rouiba) Algeria.

The reference state is denoted by as-cast state denoted: F. To increase further the state's strength characteristics F and essentially obtain large elastic stresses, great rigidity modules with low distortion, the numerical designation 42400 material is subject to specific treatments T46 [1 - 13].

3. Material used

The material (AlSi7ZnMg) used is provided graciously by S.N.V.I. These is an aluminum-based alloy containing 7% silicon by percentage weight, an amount of zinc and magnesium less than 1%, and traces of impurities. AlSi7ZnMg (42400) designates this alloy, provides safe, reproducible results, and comply with the standard, if:

- The chemical composition of the alloy remains within the expected tolerances,
- the use of the flows is observed in conjunction with the general merger rules,
- prospective treatments of degassing and refining are carried out correctly.

Chemical composition of AC-42000 alloy according to NF A57-702 standard.

The tables below show the chemical compositions of the alloy concerned according to NF A57-702 and to the actual analysis SNVI. The compositions below correspond to the composition of tolerances in the castings and sand shell. The alloys used in these tolerances composition, suitably prepared and optionally heat-treated, give test pieces having at least the well-defined mechanical characteristics. [14 - 20].

Table 1

Chemical composition of AlSi7Mg alloy

Chemical elements	Fe	Si	Cu	Zn	Mg	Mn	Ni	Pb	Sn	Ti
%NFA57-702	≤ 0,45	6,5÷7,5	≤ 0,1	≤ 0,1	0,2÷0,4	≤ 0,5	≤ 0,05	≤ 0,05	≤ 0,05	0,1÷0,2
% SNVI	≤ 0,2	6,5÷7,5	≤ 0,1	-	0,45÷0,6	≤ 0,1	-	-	-	-

The ingots delivered by the French aluminum make it easy to ensure the composition imposed in parts.

Table 2

Composition of AlSi7Mg ingots delivered by the French Aluminum

Chemical Elements	Fe	Si	Cu	Zn	Mg	Mn	Ni	Pb	Sn	Ti
% NFA57-702	≤0,35	6,5-7,5	≤0,1	≤0,1	0,25÷0,4	≤0,3	≤0,05	≤0,05	≤0,05	0,1-0,2

4. Development of the studied alloy

4.1. The casting

The melting of the metal takes place in a production gas furnace tilting from the front towards the rear. It comprises a graphite crucible capacity of 350kg whose charge is composed of 40% of new ingots AlSi7Mg i.e. 140kg and 60% returns (flyweights, holes and runners, defective parts and scrap ... etc.) i.e. 210kg and whose burners are suitably adjusted.

The liquid mass is subjected to a degassing treatment and cover in the oven, and then the metal is poured into a preheating pocket where it proceeds to the refining operation. About 0,5% of a sodium's salt mixture is introduced as a refining powder into the pouch filled with the molten metal.

Correction of the chemical composition of the liquid mass is done using new ingots of AlSi22, AlZn10 and AlMg10.

Then the parts, on the one hand, can be cast respectively in metal shells or sand moulds prepared for this purpose, so that the reference specimens are referred to as casting stock denoted F; In the other hand, they undergo specific treatments of quenching noted T and maturation and income designated by: T46

4.2. Molding

- In sand: This mold consists of two half-cavities left by the template in the packed sand. To make a mold, two model plates and two chassis are generally used. Each pattern plate leaves an imprint in the sand, the mold is then closed by joining the two frames, usually made of steel, which have centering sleeves in which pins are introduced to ensure the positioning of the two half molds and filled with molten metal to obtain the specimen by gravitation,

- In shell: In this molding method, the mold consists of two steel yokes (5% chromium), which functions is to maintain the imprints. These clevises, separated by a parting line, may have to be prepared and heated to a temperature of about (200 ÷ 300) ° C.

After analysis, the specimens molded in sand and shells of metal by gravitation have the following chemical composition: [6], [13 - 21].

Table 3

Results of the chemical analysis after control of the sand and shell molded specimens

Chemical elements	Si	Zn	Mg	Fe
% according to analysis	6,86	0,61	0,49	0,12

5. Experimental procedure

To determine the behavior of the material with respect to various stresses they may encounter during use, we reproduce these loads with static or dynamic tests usually performed on standard specimens in order to know the numerical characteristics.

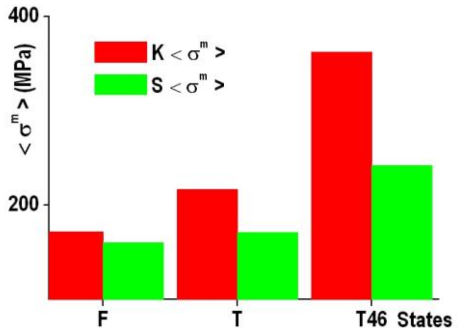
Five techniques are used, namely traction to identify various constraints, the HB Brinell hardness and micro hardness Hv for the stress field, the Kcv resilience provides information on the mode of fracture, fragility and impact resistance and microstructure to identify different structures.

We will in the following describe and present in detail, the main mechanical characteristics obtained from the AlSi7ZnMg material subject of this study. This alloy is prepared by two different methods: sand casting (noted: S) and casting in shell (noted: K) whereas 03 states; as-cast state noted: F, as-quenched state noted: T and hardened by maturation and income noted: T46 [6, 13, 20, 23].

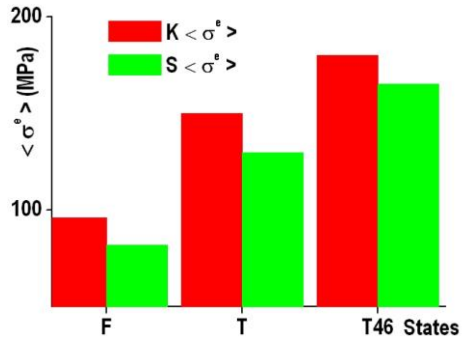
6. Results and discussion

The values of the mechanical characteristics of traction, hardness, microhardness, resilience and microstructures of the AlSi7ZnMg alloy represent the average obtained for five identical test pieces for each of the respective experimental cases. They are represented by the figures from 1 to 9 below.

6.1. Influence of molding development mode sand or shell of the AlSi7ZnMg alloy on the characteristics of resistance



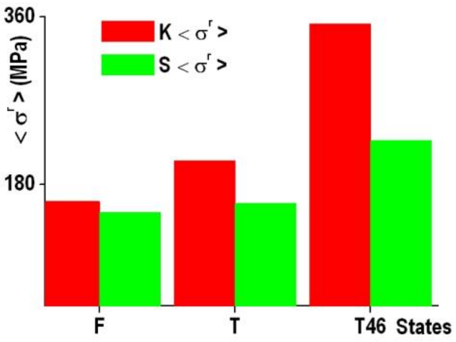
(a)



(b)

States	F	T	T46
K < σ^m >	172	216,69	362
S < σ^m >	160	171,4	242

States	F	T	T46
K < σ^e >	96	150,01	180
S < σ^e >	82	129,61	165



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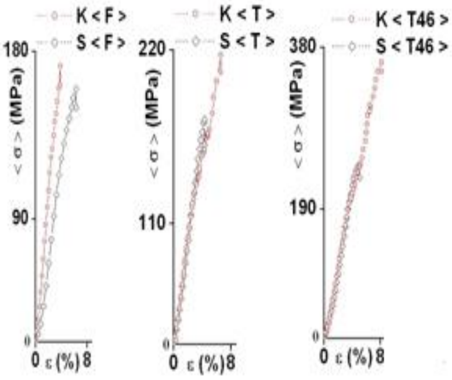
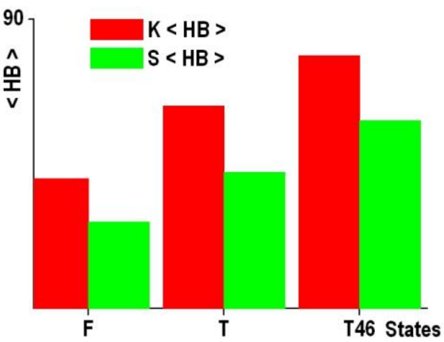


(d)

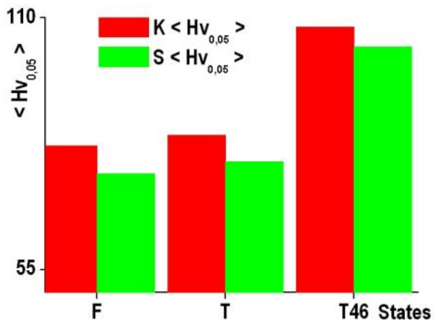
States	F	T	T46
K < σ^r >	162	206	352
S < σ^r >	150	160	227

Fig.1 - Various comparisons histograms ($< \sigma^{m,e,r} >$ – States (h)) and traction curves ($< \sigma >$ – ε (%)) of the AlSi7ZnMg alloy casted in sand (S) and in shell (K): (a) K < σ^m > / S < σ^m > - Average maximum stress (MPa), (b) K < σ^e > / S < σ^e > - average elasticity constraint (MPa), (c) K < σ^r > / S < σ^r > - average breaking stress (MPa) et (d) K < F > / S < F >, K < T > / S < T > and K < T46 > / S < T46 > with < σ > (MPa) - average traction curves, ε (%) - deformation – cast (F), quenched (T) and hardened (T46).



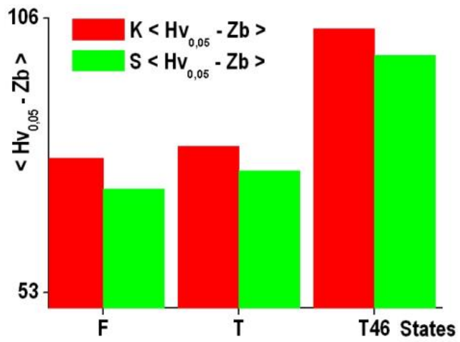
(a)

States	F	T	T46
K < HB >	68	78,05	85
S < HB >	62	68,85	76



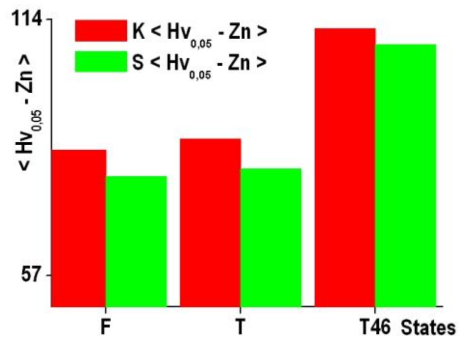
(b)

States	F	T	T46
K < HV0,05 >	82	84,3	108
S < Hv0,05 >	76	78,6	103,6



(c)

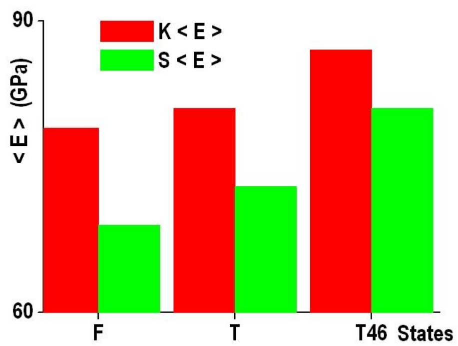
States	F	T	T46
K < HV0,05-Zb >	79	81,2	104
S < Hv0,05-Zb >	73	76,5	98,8



(d)

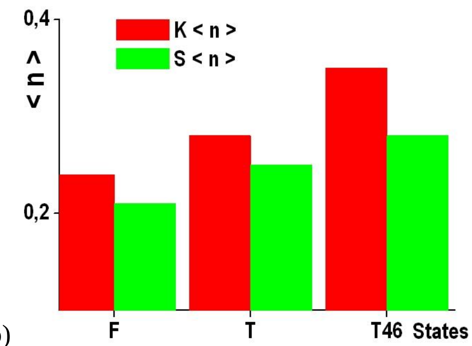
States	F	T	T46
K < HV0,05-Zn >	85	87,4	112
S < Hv0,05-Zn >	79	80,7	108,4

Fig.2 - Various comparisons histograms (< HB > and < $Hv_{0,05}$ > – States (h)) of the de AlSi7ZnMg alloy casted in sand (S) and in shell (K): (a) K < HB > / S < HB > - average Brinell hardness and (b) K < $Hv_{0,05}$ > / S < $Hv_{0,05}$ > - average Vickers microhardness, (c) K < HV0,05-Zb > / S < Hv0,05-Zb > - Vickers microhardness of the white area and (d) K < HV0,05-Zn > / S < Hv0,05-Zn > - Vickers microhardness of the black area with crude of casting (F), quenched (T) and hardened (T46)



(a)

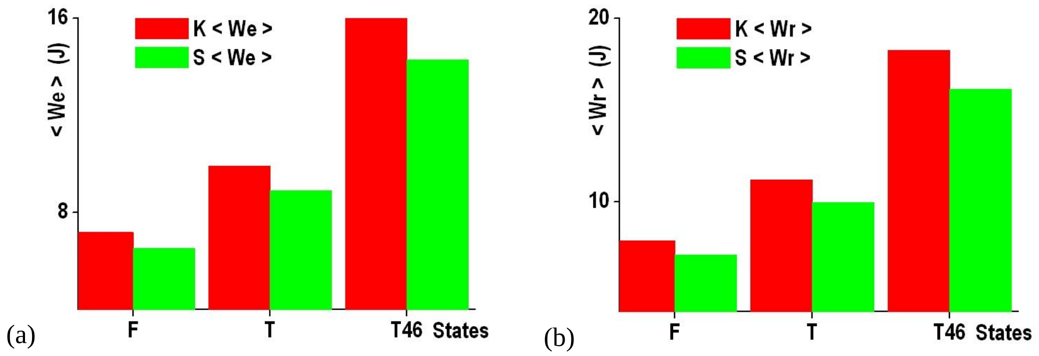
States	F	T	T46
K < E >	79	81	87
S < E >	69	73	81



(b)

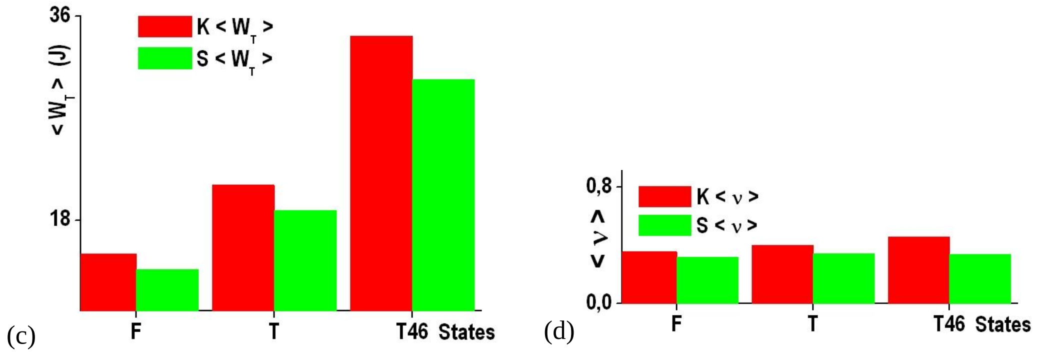
States	F	T	T46
K < n >	0,24	0,28	0,35
S < n >	0,21	0,25	0,28

Fig.3 - Various comparisons histograms (< E > and < n > – States (h)) of the AlSi7ZnMg casted in sand (S) and in shell (K): (a) K < E > / S < E > - average Young modulus (GPa) and (b) K < n > / S < n > - average consolidation coefficient with crude of casting (F), quenched (T) and hardened (T46)



States	F	T	T46
K < W_e >	7,18	9,9	15,98
S < W_e >	6,53	8,91	14,28

States	F	T	T46
K < w_r >	7,86	11,18	18,25
S < W_r >	7,11	9,97	16,13

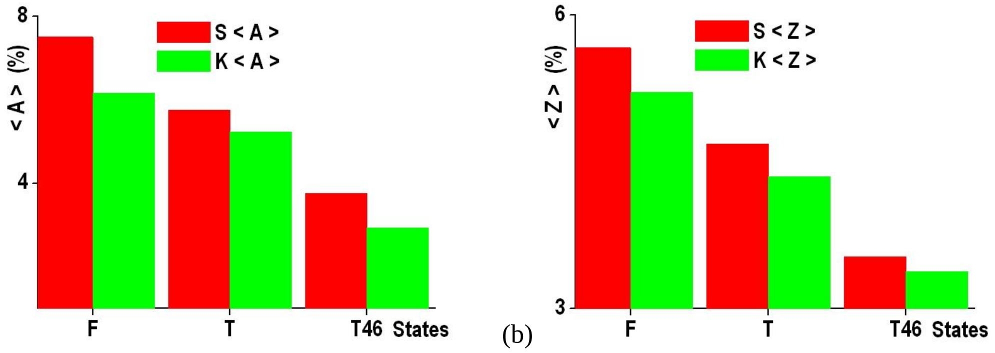


States	F	T	T46
K < W_T >	15,04	21,08	34,23
S < W_T >	13,64	18,88	30,41

States	F	T	T46
K < ν >	0,356	0,401	0,457
S < ν >	0,321	0,345	0,338

Fig. 4 - Various comparisons histograms (< $W_{e, r, T}$ > and < ν > – States (h)) of the AlSi7ZnMg alloy casted in sand (S) and in shell (K): (a) K < W_e > / S < W_e > - elastic strain energy (J), (b) K < W_r > / S < W_r > - plastic strain energy (J), (c) K < W_T > / S < W_T > - total energy (J) and (d) K < ν > / S < ν > - average Poisson coefficient with crude of casting (F), quenched (T) and hardened (T46)

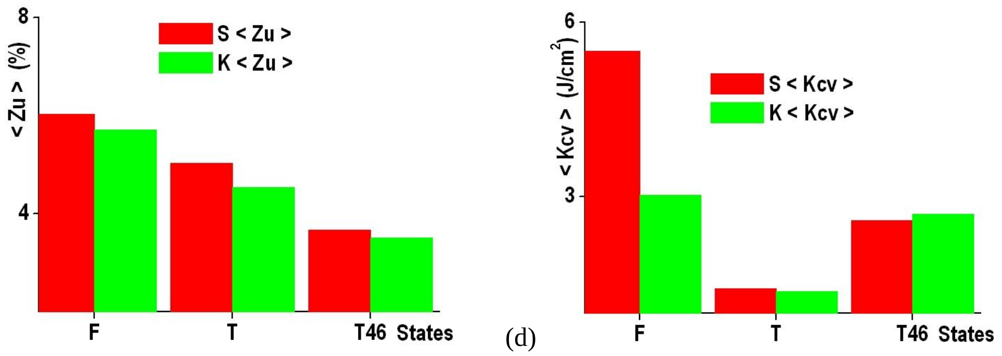
6.2. Influence of molding development mode sand or shell of the AlSi7ZnMg alloy on the characteristics of ductility



(a) (b)

States	F	T	T46
S < A% >	7,5	5,75	3,75
K < A% >	6,153	5,23	2,923

States	F	T	T46
S < Z% >	5,663	4,68	3,531
K < Z% >	5,211	4,35	3,379



(c) (d)

States	F	T	T46
S < Zu% >	6,027	5,025	3,672
K < Zu% >	5,705	4,541	3,502

States	F	T	T46
S < Kcv >	5,5	1,42	2,59
K < Kcv >	3,03	1,37	2,7

Fig. 5 - Various comparison histograms (< A% >, < Z% >, < Zu% > and < Kcv > – States (h)) AlSi7ZnMg alloy casted in sand (S) and in shell (K): (a) S < A% > / K < A% > - average elongation, (b) S < Z% > / K < Z% > - average striction coefficient, (c) S < Zu% > / K < Zu% > - average striction elongation and (d) S < Kcv > / K < Kcv > - Average resilience (J/cm^2) crude of casting (F), quenched (T) and hardened (T46).

7. Discussion

The polycrystalline 42400 alloys containing 7% by mass of Si solidifies at low temperature in large dendritic particles (α- rich Al) which revolve on precipitates (α + β) with (β- rich Si) arranged slats (Fig. 6 (a), (b)). Gradually, as the coolant temperature decreases, the lamellar fronts advance to the depletion of the liquid [20, 21, 22].

The mechanical behavior of the alloy studied at cast condition, may be due to the presence of Si concentration heterogeneities and those of the structure: nonuniform distribution of the solute element Si in the parent matrix, i.e. there may be some low areas and large Si concentrations.

In fact, the figure (Fig. 6 (a), (b)) shows the size and shape of the dendrites and their random distribution. The dimensions of the dendrites of the crude sand casting state are larger than those of the shell casting, the shell casting resistance characteristics are then higher to those of the sand casting.

The heterogeneous distribution of the Si element and the different shapes and dimensions of the dendrites create a random set of stress concentrators of different potential energy whose deformation appears and propagates in a low-resistance region up to rupture.

To obtain high levels of mechanical strength of the alloy, it is necessary to impede the movement of dislocations throughout the bulk of the material causing the formation of finely dispersed precipitates ($MgZn_2$, Mg_2Si, Si, Mg) (Fig. 7 (c), (d)), for this we have carried out a specific structural hardening heat treatment.

For a heat treatment to succeed, it is imperative to a good selection of temperature homogenization and its holding time.

The judicious choice of this temperature is double and enables

- rapid dissemination of Si solute elements in the Al parent matrix,
- avoid burns.

Regarding the homogenization time, it gives time to all unstable atoms to move to the more stable regions.

After heat treatment (Fig. 6(c), (d), 7(c), (d)), the shape and non-uniform dimensions of the dendrites obtained in the sand and shell casting states dissolve in approximate globular form with uniform distribution of the solute element Si in the matrix Al. To fix this structure, this alloy is quenched in water (20 ÷ 25) ° C. The thermal shock due to the quenching of the alloy instantly causes a field of residual internal stresses with a compression shrinkage at the surface and another of traction at the core, which is harmful to the alloy. To eliminate it, the latter is subjected to two types of aging, curing and income. This, consist in finding a structure of stable equilibrium with acceleration firstly the relaxation of the residual internal stresses, secondly, the structural hardening by precipitation which gives rise to different precipitates ($MgZn_2$, Mg_2Si, T phase ($Al_3Mg_3Zn_3$ and

T (Al_3Mg_2)) which impede the dislocation movement so that the alloy will be even more resistant.

Maturation and income treatments cause the migration of some of the alloying elements such as Si, Zn and Mg to the dislocations, which will form $MgZn_2$ and Mg_2Si precipitates.

The hardening process of the AlSi7ZnMg alloy is essentially due to the formation of transitional phases, respectively β"($MgZn_2$, Mg_2Si) hardened state: T46 coherent and β'($MgZn_2$, Mg_2Si) tempered state: semi-coherent T, and β ($MgZn_2$, Mg_2Si) raw state of casting: F incoherent with the Al matrix.

The increase in strength properties of the two production modes is closely linked to four factors that modify the microstructure:

- The deliberate addition in substitution of three elements (Si, Zn and Mg) to the Al matrix that generate either a compression stress field, which interacts with the dislocations, or diffusion towards them to pin and block them,
- The refinement of grains sizes, hence the grain joints whose role is double. They can constitute respectively traps or barriers with disappearance or accumulation of dislocations,
- The refinement of the precipitates sizes with increase in their number and their coherence with respect to the Al matrix. To overcome these precipitates, the dislocation in motion can then either shear them or circumvent them by creating defects,
- The existence of initial dislocations: In general, the generation of dislocations in the same alloy under the effect of constraints are of the same sign and repel each other. We will have to develop an additional constraint for moving dislocations near others to allow them to cross the grain boundary and move from one grain to another.

These four structural hardening mechanisms have a direct effect on the fineness of the microstructure increasing considerably the strength of the alloy for the two production modes.

Figure 1 (d) - represents various comparisons of the average traction curves of the AlSi7ZnMg cast in sand (S) and in shell (K) the as-cast state (F) quenched (T) and hardened (T46). They show that the volume deformation energy and the toughness K_C are very low. We also note the absence of the heterogeneous plastic domain, which explains why the damage occurred in a brutal way and following a vertical asymptote of deformation equations $\varepsilon_r = \varepsilon_m$ with sudden appearance and propagation of the crack.

Figures 1, 2, 3, 4 and 5 respectively show the curves and graphs of the stresses as a function of the deformation and the average strength and ductility characteristics for each the states: as-cast state (F), quenched (T) and hardened (T46) of the AlSi7ZnMg alloy cast in sand (S) and in shell (K). To compare the results obtained each group of curves and characteristics corresponding to the three states are reported on the same graph respectively for both casting methods.

It is then observed that all the curves and graphs (Fig. 1, 2, 3 and 4) corresponding to the strength characteristics of the shell cast alloy (K) are above those of the cast sand alloy (S). On the other hand, all the graphs (Fig. 5) corresponding to the ductility characteristics of the shell casting (K) are below those of the sand casting (S), this is probably due to the cooling mode which is very fast in the shell (K) and very slow in the sand (S).

Figures 1, 2, 3 and 4 shows that the graphs of stresses, Brinell hardness, microhardness, Young's modulus E, consolidation coefficient and energies as a function of states increase from the as-cast state to the as-quenched state to finally grow from it and achieve the maximum value for the state T46 at the expense of elongation, the striction and resilience (Fig.5). While the intrinsic Poisson ratio remains almost invariant (Fig. 4 (d)). Growth or decay rate is different from one property to another. It is found that the extrinsic values of the tensile strength, the yield strength, the Brinell hardness, Vickers microhardness, the consolidation coefficient, the elastic strain energy , the plastic deformation energy and the total energy of the alloy in the T46 state are higher than those of the other states whatever the casting mode (Fig. 1, 2, 3 and 4).

These results shows that the state T46 is the best compromise for resistance parts regardless considered states because the aging process was completed after a maturation time well chosen, followed by a full income at a well-defined temperature and duration.

Microstructures in the as-cast state (Fig. 6 (a), (b) and Fig. 7 (a), (b)) show dendrites and grains of different sizes with a random and non-uniform distribution of the added elements (Si, Zn and Mg) in the Al matrix of heterogeneous local structures. This leads to the formation of structural and local heterogeneities that generate a stress field varying from one point to another of the alloy. On the other hand, in matured states (Fig. 6 (c), (d) and Fig. 7 (c), (d)) they produce a uniform chemical composition. The fineness of the grain by the shell casting is more pronounced than that obtained by sand casting.

To improve the mechanical characteristics of the as-cast state, heat treatments of structural hardening have been applied, thus producing a finer structure and precipitates of different kinds (Mg_2Si, $MgZn_2$ etc.), impeding the movement of dislocations, which explain the increased strength characteristics for both production modes (Fig. 7 (c), (d)).

In Fig. 2-c, d, the graph of the microhardness of the black zone is clearly above that of the microhardness of the white zone, regardless the state considered.

The black zone is probably the solid solution of aluminum, zinc and magnesium in silicon, on the other hand, the white zone is that of silicon, zinc and magnesium in aluminum.

The improved strength characteristics of the considered alloy in matured states followed by incomes for the two production modes (Fig. 1, 2, 3, 4) is probably due to four main obstacles that can slow dislocation slip in the homogeneous plastic deformation. These obstacles are the adding in substitution of three elements (Si, Zn and Mg) to the Al matrix, the fineness and the size of the grains and of the precipitates with an increase in their number and their coherence with respect to the matrix Al, and the existence of initial dislocations.

The strength characteristics increase from the state (F) (Fig. 1, 2, 3, and 4) to the compromised state T46 of maximum resistance and precipitation properties whatever the casting mode. The T46 state has a finer microstructure with intragranular precipitates, uniformly distributed, homogeneous and coherent with respect to the Al matrix.

The analysis of experimental results (Fig. 1, 2, 3, 4) shows us that the best compromise is the shell casting method followed by a precipitation treatment T46, regardless of the states considered.

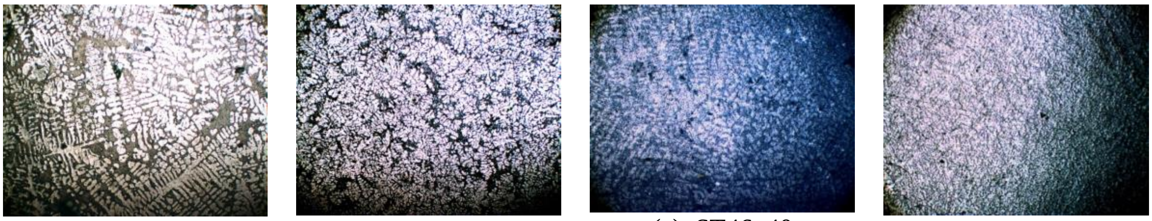
AlSi7Mg hypoeutectic alloy has a semi-fragile behavior for five main reasons: elongations at break are low, the values of the constriction coefficients Z are low, Kcv resilience is very low, Kc tenacity or deformation energies are very low. Fifthly, absence of the heterogeneous plastic domain because the damage occurred in a brutal way and following a vertical asymptote of deformation equation $\varepsilon_r = \varepsilon_m$ with sudden appearance and propagation of the crack on a defect.

The tensile and resilience fracture surfaces (Fig. 8 and 9) show that their fracture is semi-fragile intragranular with cleavage and exhibit a glossy appearance

Their mean curves (stress - strain) (Fig. 1 (d)) reveal only two domains: a large elastic domain and a very restricted homogeneous plastic domain where the instantaneous damage begins by a striction of the test part with sudden appearance and propagation of the crack on a defect.

In this case, we are in the presence of the rupture mode probably of type I with severe loading and perpendicular to the crack plane.

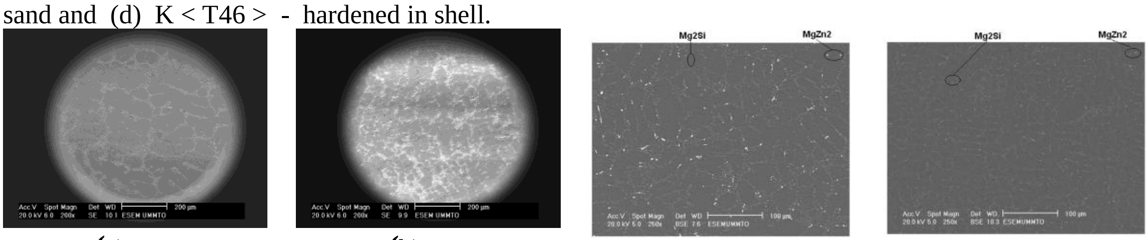
8. Microstructure of the AlSi7ZnMg polycrystalline alloy



(a) SFx40 (b) KFx40 (c) ST46x40 (d) KT46x40

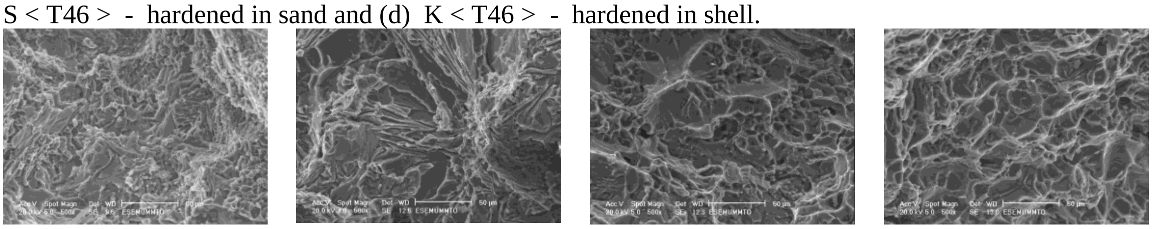
Fig. 6 – Micrographic structure of the AlSi7ZnMg alloy casted in sand (S) and in shell (K): (a) S < F > - crude of sand casting , (b) K < F > - crude of shell casting, (c) S < T46 > - hardened in

sand and (d) K < T46 > - hardened in shell.



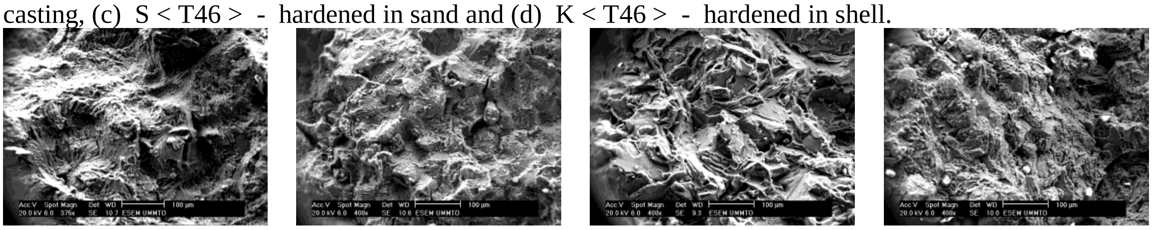
(a) SF (b) KF (c) ST46 (d) KT46

Fig. 7 - Microstructures obtained with a scanning electron microscope (SEM) of the AlSi7ZnMg alloy cast in sand (S) and in shell (K): (a) S < F > - crude of sand casting , (b) K < F > - crude of shell casting, (c) S < T46 > - hardened in sand and (d) K < T46 > - hardened in shell.



(a) SF (b) KF (c) ST46 (d) KT46

Fig. 8 - Tensile fracture surfaces obtained with a scanning electron microscope (SEM) of the AlSi7ZnMg alloy casted in sand (S) and in shell (K): (a) S < F > - crude of sand casting , (b) K < F > - crude of shell casting, (c) S < T46 > - hardened in sand and (d) K < T46 > - hardened in shell.



(a) SF (b) KF (c) ST46 (d) KT46

Fig. 9 - resilience fracture surfaces obtained with a scanning electron microscope (SEM) of the AlSi7ZnMg alloy casted in sand (S) and in shell (K): (a) S < F > - crude of sand casting , (b) K < F > - crude of shell casting, (c) S < T46 > - hardened in sand and (d) K < T46 > - hardened in shell.

9. Conclusion

Generally, heat treatments lead to a significant change in the microstructure. In this study, we have investigated their influence on the evolution of the elasticity, plasticity, ductility and structural characteristics of the AlSi7ZnMg alloy casted by gravity in sand and shell.

The purpose of this work is to study the thermal processing capacity of the AlSi7ZnMg alloy by considering three states: as-cast state noted F, quenched noted T and hardened by maturation and income noted T46. In order to improve the mechanical properties obtained from the as-cast state, a precipitation hardening treatment is used. The addition of zinc and magnesium is required to increase sensitivity to the specific heat treatment. This is followed by homogenization that generates a diffusion of atoms in a substitutive solid solution inside a tempering furnace set at 500 ° C for 10 hours. Immediately thereafter, undergo quenching it in water at room temperature (20 to 25) ° C, followed by natural aging for 12 hours and an income at 160 ° C for four hours in an oven enclosure and cooled in the open air.

In shell casting, as in sand casting, the compromise of resistance characteristics is achieved by the T46 treatment with a ductility compromise.

For safety reasons, small and medium parts must be casted in metal shells followed by a T46 treatment, on the other hand for large parts and for economic reasons it is recommended to cast in sand followed by the same compromise.

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