CELLULAR PRECIPITATION IN THE Mg- 8 wt.%Al ALLOY

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ABSTRACT

The reaction of precipitation in alloys of system Mg-Al was the theoretical and experimental investigation object many having contributed to the comprehension of the various mechanisms controlling. The goal of this work is the description, on the one hand mechanisms controlling this reaction and the modifications of the mechanical properties which accompany them at the time of ageing of the alloy Mg-8 mass.% Al with 200°C and on the other hand the effect of the plastic deformation on the kinetics of precipitation. The techniques of analysis used in this respect are: optical microscopy, the diffraction of x-rays and it micro Vickers pyramid hardness.

Key words: alloy Mg-Al; precipitation; mechanism; deformation.

1. INTRODUCTION

the transformations of the most important phases those which appear in the supersaturated solid solutions representing only one phase with the state of balance?0 and whose stable state corresponds to two phases, one? impoverishes in elements of alloy and of the same structure than the initial phase?0 and the other? precipitated phase rich in elements of alloy and different structure. Is this transformation indicated by the term precipitation east corresponds to the reaction?0? +? [1]. The processes of precipitation which utilize the phenomenon of diffusion are generally classified in two principal categories with knowing: - precipitation continues or germination is homogeneous and appears completely randomly in all alloy and one of the principal characteristics of this reaction is the variation continues lattice parameter of the initial phase?0 and concentration in atom of aqueous solution. - and the discontinuous precipitation whose germination is heterogeneous, implying the presence of two distinct areas, of which one is transformed in cellular form (? +?) alternated downstream from a mobile grain boundary and the other not transformed. It takes place preferably and initially on heterogeneities of the mother phase?0 which can be dislocations, surfaces of impurities or grain boundaries. Its characteristic during ageing is the discontinuous variation of the lattice parameter of the mother phase. These two reactions do not have the same probability of appearance under thermal conditions given [2].

The cellular precipitate is formed only in alloys of this system with an aluminium concentration higher than 6% [147] 3 the study made by J.Gjonnes [148] 4 showed that precipitation continues in this alloy system appears only with high and low temperatures, while the intermediate temperatures support discontinuous precipitation. At the high temperatures discontinuous precipitation disappears because on the one hand the volume diffusion prevents its growth and on the other hand its germination becomes difficult. At low temperature, the precipitation continues which occurs at the beginning of annealing blocks the initiation of discontinuous precipitation. The maximum values of the microhardness are obtained at the end of the reaction of precipitation, on the other hand the coalescence of the cells leads to a reduction in the microhardness and an increase in the distance interlamellaire without spheroidizing. As he is known, the plastic deformation just after hardening introduces defects into the matrix leading to the acceleration of the process of precipitation. However in this alloy system ageing at high temperatures can start in more of the process of precipitation, the process of recrystallization which can involve a deceleration of the process of the precipitation controlled by the diffusion. That means that the recrystallization led to the formation of a new matrix containing much less dislocations and to grains finer than those of hammer-hardened alloy. But the germ formation of a new phase within a solid solution supersaturated and deformed after hardening, can be opposed to the movement grain boundaries and consequently, delay the recrystallization and conduit with an interaction between precipitation and the recrystallization [149]. 5

Indeed for the creation of the heterogeneous structure desired starting from the supersaturated and deformed solid solution, the determination of the intervals of temperatures of ageing is necessary. In this alloy system the influence of the plastic deformation on the kinetics of discontinuous precipitation is documented little, it seems to have a nongeneral role, it depends on alloy in question, because it can accelerate or delay the kinetics of the precipitation discontinuous and/or associated the recrystallization [150, 151] 6,7.

2. EXPERIMENTAL METHODS

the alloy Mg-8 mass.% Al is prepared by fusion under inert atmosphere starting from components (Mg et al.) of high purity. The ingots obtained were homogenized with 440°C during 50 days, then soaked in frozen water. The samples intended for experimental work have undergoes a second homogenisation with 440°C during 36 hours and soaked in frozen water. The conditions of the annealing of dissolution are obtained simultaneously starting from the literature and from the diagram of balance of the alloy Mg-Al system. The temperature of selected ageing is about 220°C. The deformation of the samples was obtained by cold rolling. Considering the oxidizing atmosphere which reigns in the furnace, a whole of vacuum annealing was conceived in this respect. For the metallographic test one used the reagent of Keller (07 ml of hydrofluoric acid, 09ml of hydrochloric acid, 20ml of nitric acid and distilled water 85ml). Optical microscopy, the diffraction of x-rays and the Vickers microhardness are the principal methods of analysis

3.RESULTS AND DISCUSSION

ageing with 220°C led to the formation of the cellular precipitate, which is confirmed by optical microscopy as shows it the figures 1a and 1b, i.e. this temperature is only favorable to cellular precipitation developing on the grain boundaries. The morphology of the precipitate varies from a place to another. In the same way the mechanism S of growth proposed by Fournelle is more dominating (fig. 2a and 2b). The microhardness increases starting from the value obtained with the state of hardening until a maximum corresponding to one duration period 47 hours to decrease then (fig.3), this decrease is with the coalescence of the precipitated cells. In the same way the diffraction of x-rays confirms precipitation in this alloy (fig.4). The effect of the deformation is remarkable on the speed of precipitation, whose defects introduced by plastic deformation can play an essential part to stimulate the reaction of precipitation. Figure 5 shows for the same conditions of ageing the effect of the plastic deformation

4. CONCLUSION

the whole of the results presented in this work reflects in particular the effect of the temperature on the mode of precipitation in the alloy Mg-8 mass.%Al. A predeformation with ageing with 220°C revealed the structure of widmannsttaten, with a growth in the form of needles and leading to a continuous precipitation. Precipitation continues is favoured with high and low temperatures, while discontinuous precipitation dominates at the intermediate temperatures. The high temperatures relatively accelerate the process of diffusion and the mechanism S is more dominating in discontinuous precipitation. Hardening was observed at all the temperatures of ageing; however the prolongation of the duration period of ageing led to a fall of hardness.

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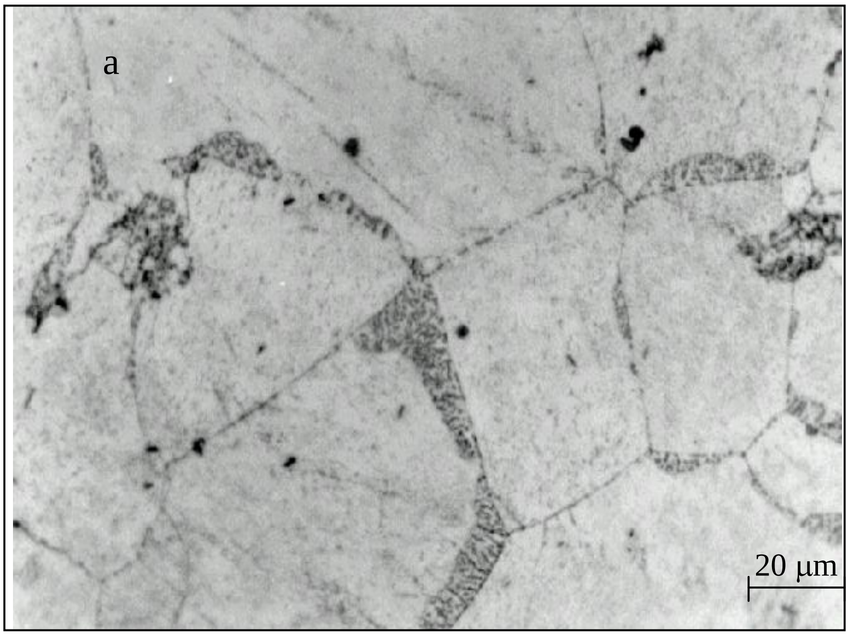

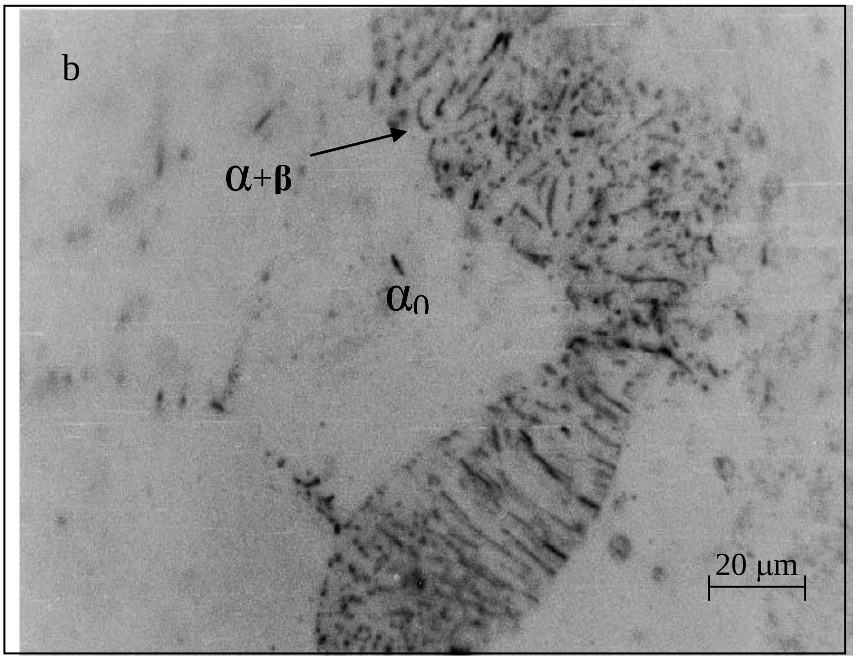

Figure. 1 Structural evolution of the Mg-8 mass.%Al alloy, homogenized at 440°C during 50 days, quenched in ice water, homogenized at 440°C during 36h, quenched in ice

water and aged at 220°C during 22h.

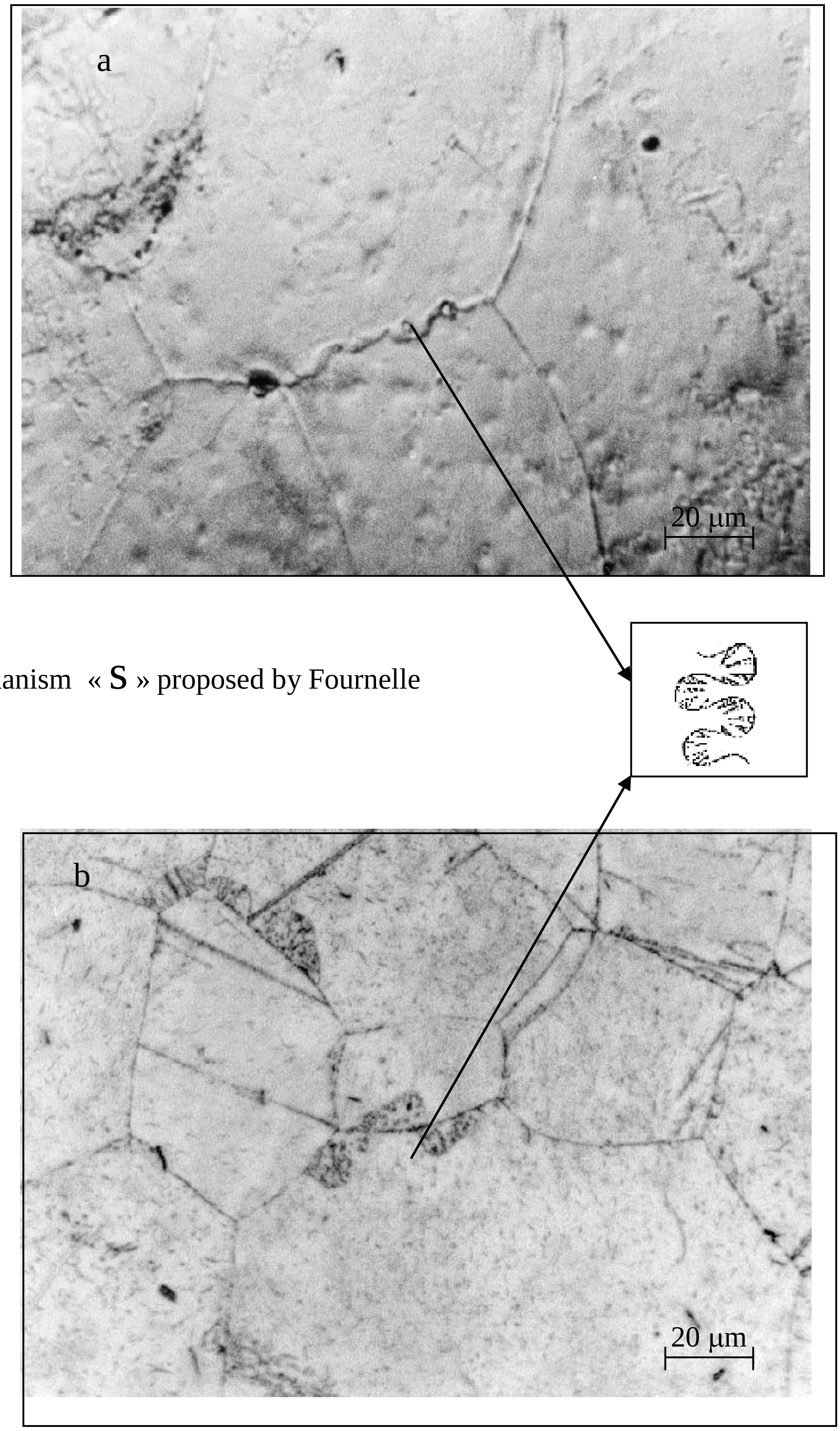

Figure. 2 Structural evolution of the Mg-8 mass.%Al alloy, homogenized at 440°C during 50 days, quenched in ice water, homogenized at 440°C during 36h, quenched in ice water aged at 220°C during 22h.with the description of the mechanism S.

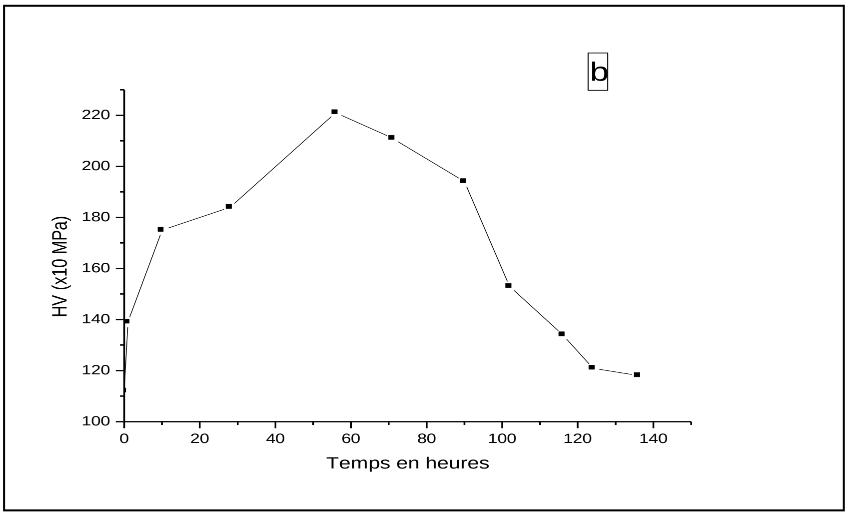

Figure. 3 Microhardness evolution of the Mg-8 mass.%Al alloy, homogenized at 440°C during 50 days, quenched in ice water, homogenized at 440°C during 36h, quenched in ice water and aged at 220°C during 22h.

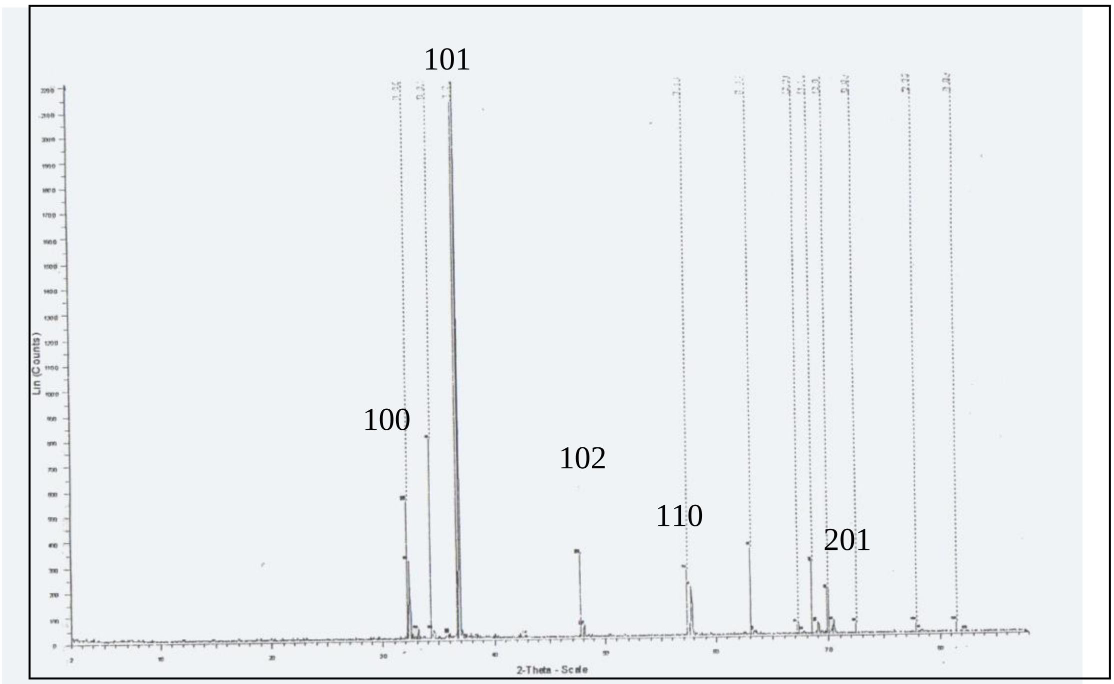

Figure.4 X-rays diffraction of the Mg-8 mass.%Al alloy, homogenized at 440°C during 50 days, quenched in ice water, homogenized at 440°C during 36h, quenched in ice water and aged at 220°C during 22h.

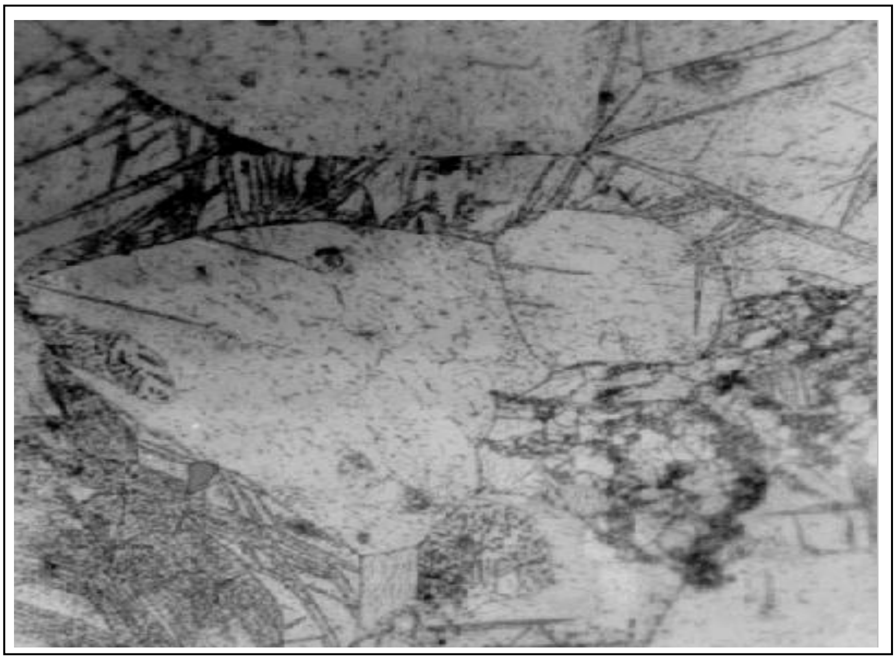

Figure. 5 Structural evolution of the Mg-8 mass.%Al alloy, homogenized at 440°C during 50 days, quenched in ice water, homogenized at 440°C during 36h, quenched in ice water, deformed at 35% and aged at 220°C during 22h.