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Evolution of Microstructure During Creep of Thermally Treated Zn-Al-Cu Alloys

J. Lecomte-Beckers, L. Terziev* and J. Wegria**

University of Liège, Dept of Metallurgy and Materials Science, Rue A. Stévart. 2, B-4000 Liège, Belgium
** Universite de Sofia, Faculty of Chemistry, Boul. J. Bourchiers 1, BG 1126 Sofia, Bulgaria*
*** Union Minière, C.M.P., BP. 1, 59950 Auby-Lez-Douai, France*

1. INTRODUCTION

Thermal treatment of Zn-Al-Cu alloys containing up to 2 Wt % of Al and 27 Wt % of Al leads to a cellular reaction with formation of lamellae, one made of FCC supersaturated solid solution α_S and the other of HCP η phase. The isothermal ageing leads to the precipitation of zinc from α_S, to the development of several metastable phases : ellipsoïdal G.P. zones, α'' phase, rhomboedral precipitates (α'_r) and h.c.p. precipitates (η_X, η_m) and to the transition from one to another. Depending on the composition and the thermal treatment the precipitation may take place in various ways [1, 3]. The copper is found preferentially in the form of elongated ε precipitates ($CuZn_4$) in η lamellae. Appropriate thermal treatment (one week at 250°C) gives rise to a very fine well dispersed microstructure with fine precipitates of coherent G.P. phases, α'_r and η_X precipitates that improves the thoughness and the creep resistance at high temperature ($> 0.4\ T_F$).

This paper illustrates the modifications of the structure induced by creep treatments. The aim of this study is to compare the evolution of the structure after creep tests on samples treated at 100°C and 250°C. Creep tests have been carried out at 120°C with a tensile stress of 40 MPa and at 20°C with a tensile stress of 100 MPa.

2. RESULTS AND DISCUSSION

The applied stress during creep tests does not modify the evolution of the transition phases but modify their size, quantity and forms. Meanwhile during creep tests, due to the applied stress, a large amount of defects are created (fig. 1)

Moreover the lamellae are thinner and more elongated comparing to samples before creep. The density of defects is more important after creep at room temperature. This can be explained by time to rupture which is longer and by the intensity of the stress (100 MPa).

Particles of T' and θ' phases are formed on these defects (Fig. 2). The transformation $\alpha + \varepsilon \longrightarrow T' + \eta$ and $T' \longrightarrow \theta'$ is easy because the diffusion of zinc is inhanced by the presence of defects. In comparison T' phase is rarely found and θ' phase never appears in samples before creep. The size of these precipitates is smaller when the initial heat treatment has been performed at 100°C. The parameter of the rhomboedral T' phase are a = 8.67Å

$\alpha = 27.405$

The interpretation of diffraction patterns indicate the relations between matrix and T' phase :

$$(100)_{T'}//(111)_{\alpha}$$
$$(010)_{T'}//(112)_{\alpha}$$

θ' phase develops from T' phase and on defects aligned following the $\{110\}$ θ' planes and parallel to the ⟨100⟩ θ' directions. Relations between θ' phase and matrix are

$$(001)\theta' //(111)\alpha$$
$$[010]\theta'//[10\bar{1}]\alpha \text{ and } [100]_{\theta'}//[121]_{\alpha}$$

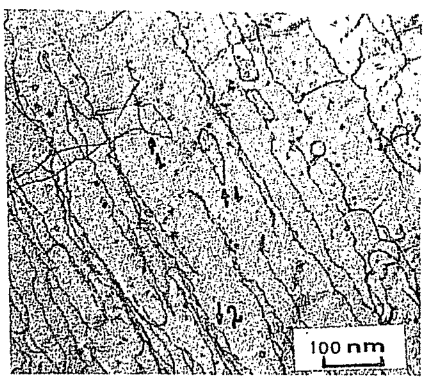

Fig. 1 : Ageing at 250°C during one week and creep at 20°C - presence of numerous dislocations.

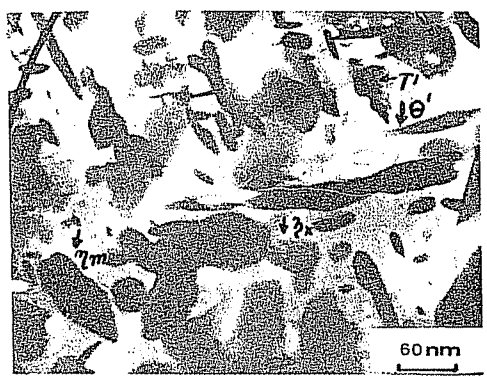

Fig. 2 : Ageing at 250° during one week and creep at 120°C - presence of η_m and η_x phases, of T' and θ' phases.

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