The Al-30 wt.% Zn alloy containing metastable α_R or α' precipitates was cold rolled to investigate the effect of plastic deformation on transformation processes during the subsequent ageing at 200 °C. Transmission electron microscopy and X-ray diffraction studies proved that the deformation leads to the rapid decomposition of deformed α_R and α' precipitates and enhances also the decomposition of α' precipitates formed from α_R to α' transformation. The deformation does not, however, change the growth rate of α' particles. It leads, therefore, to the decrease of critical sizes of α' particles for the α' to β transformation. The increasing degree of deformation enhances the density of nucleation sites for the β formation on α/α' interfaces and leads to the decrease in sizes of stable β precipitates. The acceleration of transformation processes is associated with the partial relaxation of stresses introduced by the applied deformation.

1. INTRODUCTION

The optimum properties of modern construction materials are often associated with the development of metastable microstructures. It is therefore necessary to investigate their stability during the exploitation of materials [1]. Applied static and cyclic loads leading to creep and fatigue processes belong to very important factors affecting the degradation of microstructures. A more detailed understanding of such processes is associated with the knowledge of the influence of deformation on the structure changes within the alloys which reach the equilibrium state by the intermediate development of metastable phases.

The aim of this paper is to investigate the influence of deformation on the metastable microstructures developed in Al-Zn alloys since they provide a variety of metastable phases the stability of which can be affected by the applied deformation. In Al-30 wt.% Zn alloy the full transformation sequence [2] was found from 161 °C to 255 °C [3], i.e. supersaturated α → spherical G-P zones → ellipsoidal G-P zones → rhombohedral α_R → cubic α' → hexagonal β + equilibrium α. Our recent results revealed that the kinetics of transformation processes in these alloys were already affected by the deformation introduced by various rates of quenching [4] and by different degrees of cold rolling [5] applied after the solution treatment. This paper deals with the study of the influence of cold rolling on the decomposition of metastable precipitates developed during the preceding heat treatment of the investigated alloy. The initial microstructures correspond to alloys with metastable rhombohedral α_R precipitates partially coherent with the α matrix and to alloys with semicoherent cubic α' precipitates.
2. EXPERIMENTAL PROCEDURE

Our investigation was carried out on the Al-30 wt.% Zn alloy prepared from Al and Zn of 99.99 wt.% purity. Chemical analyses of samples gave the content of 30.2 ± 0.2 wt.% Zn.

All investigated samples were solution treated 1 hour at 490 °C and subsequently water-quenched. The ageing at 200 °C comprising various ageing times was then applied to develop the metastable $\alpha'$ and $\alpha$ precipitates of different sizes within the $\alpha$ matrix. Such samples were then deformed by the cold rolling to reach the reduction of thickness of 84%, 50% and 30%, respectively. Samples with the deformed metastable precipitates were then subsequently aged at 200 °C during various ageing times. The respective structure changes were examined by the transmission electron microscopy, present phases were identified by X-ray diffraction.

3. RESULTS

3.1. Influence of deformation on transformation of $\alpha_R$ precipitates

The investigation was carried out on samples with two different mean lengths $l$ of $\alpha_R$ precipitates grown at 200 °C during the ageing times of 30 minutes ($l = 30$ nm) and of 5 hours ($l = 0.1$ μm).

After 30 minutes of ageing at 200 °C the start of G-P zones to $\alpha'$ transformation was observed. The application of 84% deformation leads then to the very fast $\alpha'_R$ to $\alpha'$ transformation by the spheroidization of $\alpha'_R$ particles.

The mean diameters of spheroidal $\alpha'$ precipitates were measured in samples aged up to 420 minutes. Obtained results are plotted in fig. 1 where the full line indicates the growth kinetics of $\alpha'$ precipitates in the undeformed samples from [5]. The comparison of both results shows that the growth rate of $\alpha'$ is not affected by the applied deformation.

![Fig. 1. Influence of deformation on the growth rate of $\alpha'$ particles formed from the deformed $\alpha'_R$ precipitates grown at 200 °C: ○ $\alpha'_R$ after 30 minutes, 84% deformation; × $\alpha'_R$ after 5 hours, 84% deformation; △ $\alpha'_R$ after 5 hours, 50% deformation; □ $\alpha'_R$ after 5 hours, 30% deformation; solid line corresponds to the undeformed sample.](image-url)