MODIFICATION OF THE D16 ALUMINUM ALLOY STRUCTURE BY PULSED RELATIVISTIC ELECTRON BEAM

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The influence of a pulsed intense relativistic electron beam on mesoscopic structural characteristics of D16 aluminium alloy plates is studied. The phenomenological parameters of superplastic flow of alloy D16 plates after irradiation is determined and compared with those before irradiation. The possible causes of improvement in superplastic flow parameters of irradiated material are analyzed.

PACS numbers: 62.20.Fe, 62.20.Hg, 41.85

1 INTRODUCTION

Many methods of metallic material structure modification are known, in particular, explosion processing, temperature hardening, ennobling melting down with an electron beam. High-current electron beam processing of a material allows to simulate all the above-mentioned methods due to the fact that when local beam energy concentrations are higher then $10^7$ J/cm$^2$ the pressure in the target reaches the value of several megabars [1, 2].

Because the maximum of beam energy absorption is reached on the target surface, the surface microexplosion takes place which is accompanied with a shock-plastic wave in the target due to heat exchange. The effects mentioned were the base for studying the structural characteristics and mechanical properties of aluminium alloy plates exposed to pulsed high-current relativistic electron beam.

2 MATERIALS AND METHODS OF EXPERIMENT

Initial plates of D16 aluminum alloy (4.8% Cu; 1.5% Mg; 0.8% Mn; impurities of Fe and Si<0.5%; Al based) with the thickness 3 mm were cut out from the massive ingot of the industrial semi-finished product and irradiated from both sides with a high-current electron beam. High-current electron beam processing based) with the thickness 3 mm were cut out from the massive ingot of the industrial semi-finished product and irradiated from both sides with a high-current electron beam. High-current electron beam processing of a material allows to simulate all the above-mentioned methods due to the fact that when local beam energy concentrations are higher then $10^7$ J/cm$^2$ the pressure in the target reaches the value of several megabars [1, 2].

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Mechanical tests were conducted in the temperature range $T=713-183$K. The largest elongation at rupture was demonstrated by samples (irradiated and unirradiated) which were deformed at $T=773$K. The elongation at rupture $\delta$ as a function of the applied yield stress $\sigma$ for unirradiated samples is demonstrated in Fig.3 (line 1). One can see that samples showed a rather low...
values of elongation at rupture. Dependence of $\delta$ on $\sigma$ has a maximum, when $\sigma=3.0$ MPa ($\delta=72\%$). Dependence of $\delta$ on $\sigma$ for irradiated samples is shown in Fig. 3 (line 2). One can see that for the low strains the value $\delta$ is larger for irradiated samples. The maximum of $\delta$, as for unirradiated samples, is realized when $\sigma=3.0$ MPa ($\delta=133\%$).

![Fig. 1. Microstructure of D16 alloy: a) initial; b) after irradiation.](image1)

Although unirradiated samples have the elongation at rupture almost in 2 times less then irradiated ones, nevertheless one and another have phenomenological parameters peculiar to superplastic materials. Therefore, probably, grain boundaries are in a nonequilibrium state, typical for superplasticity, that makes possible their intensive creeping. However, the cause of a quick breaking of deformed samples probably is the existence of coarse inclusions of undissolving phases. Irradiation, apparently, makes it possible to decrease a size of inclusions and increase $\delta$.

![Fig. 2. View of the surface of irradiated alloy D16 plate: a) in ordinary light; b) in polarized light.](image2)

4 CONCLUSION

1. Irradiation of the alloy D16 plates with a pulsed relativistic electron beam leads to formation in them the ultrafine-grained and uniaxial structure.
2. Parameters of superplastic flow of irradiated samples are better then these of unirradiated ones. This is probably related with distinction in grains and redistribution of consolidating phase particles.

REFERENCES