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FEATURES OF MECHANICAL AND MICROSTRUCTURAL BEHAVIOR IN ECA PRESSED NANOSTRUCTURAL AL-LI ALLOYS UNDER HIGH STRAIN RATE SUPERPLASTICITY

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The structure of rods subjected to the equal-channel angular (ECA) pressing under different conditions have been studied by X-ray diffraction analysis, transmission electron microscopy, scanning electron microscopy, including back electron scattering diffraction and orientation image microscopy, technique. A fine-grained structure has been shown to form in the process of pressing, finer grains forming at lower pressing temperatures. A largest number of grains demonstrate the formation of a dislocation substructure involving subgrains bounded by dislocation boundaries. A most developed substructure forms under pressing at elevated temperatures when coarser grains form.

A mechanical behavior has been studied for ECA pressed samples having different structural states. Temperature and strain rate conditions to attain ultimate strains to failure have been defined for samples of each structural state. It has been shown that samples with a developed substructure are subject to a superplastic (SP) straining. Contrary to the expectations the ductility of finest-grained samples turned out low. It has been found that the ultimate SP straining to failure is characteristic of samples subjected to 10-pass ECA pressing at 370°C. It complies with the strain rate of 10^{-2} s^{-1} at 370°C. Its greatest value was about 2000%.

Mechanical behaviour of the alloy has been studied in SP straining conditions. Multistage high strain rate of SP strain has been shown. Dependencies of the true strain rate on temperature, the true stress and true strain for the straining during hardening stage and softening stage have been established. The activation energies and the coefficients of strain rate sensitivity of stress (m), which characterize these stages, have been determined. It has been shown that the strain up to ~2000% corresponds to this alloy and $m \approx 0.45$ for both stages. These parameters really correspond to SP flow.

It has been established that the hardening stage deformation has the strain rate $\sim 10^{-2}$ s^{-1} and is controlled by volume self-diffusion. This is typical for SP deformation by intra-grain sliding. Dynamical recrystallization on sub-grain level corresponds to this stage. It has been established, that during the softening stage the strain rate is $\sim 10^{-3}$ s^{-1} and is controlled by grain boundaries self-diffusion. This is typical for SP deformation of fine-grain materials, which is caused by grain boundary sliding. Structural behavior by SP straining conditions has been studied. The data showing intra-grain sliding during the hardening stage and dynamic recrystallization with participation of grain boundary sliding and migration during the softening stage have been obtained.

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