Al-Be-Mg alloy strength and plasticity within 300 to 4.2 K temperature range

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Experimental data on mechanical properties of Al-Be-Mg alloy have been obtained in a wide temperature range. A maximum at 30 K has been revealed in temperature dependences of both characteristics. The alloy mechanical properties have been found to be defined by its structure state. The distribution character and orientation of Be particles in aluminum matrix are in correlation with the observed anisotropy of mechanical properties.

Получены экспериментальные данные о механических свойствах сплава Al-Be-Mg в широком интервале температур. На температурных зависимостях обеих характеристик обнаружены максимумы при 30 K. Установлено, что механические свойства сплава определяются его структурным состоянием. Характер распределения и ориентация частиц Be в алюминиевой матрице коррелирует с наблюдаемой анизотропией механических свойств.

Aluminum-beryllium alloys exhibit a complex of valuable physical and mechanical properties. Due to high specific elasticity modulus, these alloys are materials of good promise for structures where rigidity parameter is critical. At the same time, the presence of plastic aluminum matrix surrounding the beryllium phase particles favors the reduced stress concentration and hinders the crack formation and propagation. That is why the aluminum-beryllium alloys can be used under complex stress conditions, are more isotropic and 10 to 15 times more tenacious than the usual beryllium [1].

The properties of binary alloys can be improved considerably by additional alloying with additives of elements that are appreciably soluble in the aluminum matrix and increase its strength. For example, the Al–Be–Mg system alloys (Al, 67 %; Be, 28 %; Mg, 5 %) in solid state consists of a mixture of two phases, Be + α_{Al} where Be is a beryllium based solid solution and σ_{Al}, a solid solution of Mg in Al [2]. The α_{Al} phase hardening by magnesium under conservation of its high plasticity improves considerably the characteristics of two-phase Al–Be–Mg alloys. There are, however, no data on mechanical and thermophysical characteristics at low temperatures for most of those alloys as well as information on quantitative relationships between the physical properties of the materials and their structure state.

This work is aimed at the study of mechanical properties and structure of the ABM-1 alloy in the 4.2 to 300 K temperature range.

The 50 mm long material samples of 4 mm in diameter for tension tests were cut out of an initial cylindrical ingot of ABM-1 alloy along the ingot axis (L type) and across it (C type). The average grain size in the samples was 22 μm. The alloy samples showed a texture due to the material preparation procedure and being characterized, in particular by the beryllium grains elongated along the ingot axis. The samples were strained at the rate of $5 \cdot 10^{-4}$ s^{-1} using an