COMBINED AGING OF BERYLLIUM BRONZE

P. P. Duraev, Yu. A. Kaplun,
Zh. P. Pastukhova, and A. G. Rakhshtadt

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The present article evaluates the possibility of increasing the resistance of beryllium bronze to small plastic deformations as a result of the application of stepped aging under stress.

It is known [1-4] that after stepped aging of dispersion-hardening alloys the dispersity of the particles of the precipitating phase and the uniformity of their spatial disposition increase, and in the process of aging under stress there occurs oriented precipitation of particles of the second phase. It may be assumed that as a result of applying a load to the specimens in the process of stepped aging, all the above-described structural changes will take place simultaneously in the alloy.

Low-temperature aging under conditions of bending under a stress of about 100 MPa was applied to alloy BrBNT1,9Mg at 150, 180, and 210°C, high-temperature aging at 300 and 340°C under stress (100 and 200 MPa) and without stress.

It was established that in the process of low-temperature aging under stress and without stress, the electrical resistivity (ρ) of the alloy BrBNT1,9Mg increases, but in the former case the intensity of the increase of ρ is somewhat smaller; this indicates that the disintegration of the supersaturated solid solution slows down under the effect of stresses. Low-temperature aging of the alloy under stress was carried out by a regime that ensured that maximum electrical resistivity was attained because in this case, in particular, stepped aging has the greatest effect [2].

It is known that the initial stages of aging causing an increase of ρ correspond to the formation in the structure of the alloy of disperse particles of the second phase, coherent with the matrix and having the shape of disks whose habit plane coincides with the planes {100} of the matrix. In the process of aging without stress, particles with all three possible orientations form in the structure of the alloy. It was established that in low-temperature aging under conditions of stresses acting, oriented precipitation of particles of the second phase occurs. Depending on the direction in which the external load acts in relation to the crystallographic planes, particles with one, two, or three orientations precipitate in the matrix. Yet only such particles form whose habit plane is parallel to the axis of load application.

In the evaluation of the possibility of applying stepped aging for increasing the resistance of bronze to small plastic deformations, the thermal stability of the nuclei is very important. In the case of stepped aging under stress the question is also very important whether the oriented state of the particles of the second phase, established in low-temperature aging under stress, will be maintained in the subsequent high-temperature aging.

An analysis of the results of electron microscopy showed that the oriented disposition of particles of the second phase, found after low-temperature aging under stress, is partly maintained also after high-temperature aging without stress. High-temperature aging after low-temperature aging effected under stress or without it provides for a higher elastic limit (780 and 840 MPa, respectively) than is obtained after a single aging (760 MPa).

We investigated the change of the structure of the alloy BrBNT1,9Mg as a result of applying a load, both at the low-temperature (first) stage and at the high-temperature (second) stage of stepped aging. The application of a load at the second stage of aging of the alloy helps maintain the oriented disposition of the particles forming during low-temperature aging and the oriented precipitation of new particles; this increases the resistance of the alloy BrBNT1,9Mg to small plastic deformations. The elastic limit of beryllium

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bronze increases with increase of the acting stresses. As a result of applying stepped aging under stress we managed to raise the elastic limit of the alloy BrBNT1,9Mg to 900 MPa. Further increase of the applied load leads to an undesirable increase of creep strain associated with low strength properties of the alloy in the initial state.

It should be noted that stepped aging under stress has a substantial effect on the relaxation stability of the alloy, and this is an important characteristic of elastic sensitive elements. For instance, after stepped aging under stress, the residual strain accumulated in the process of relaxation tests of the alloy under conditions of static loading (σ_0 = 800 MPa) for 500 h $\varepsilon_{res} = 2.3 \cdot 10^{-5}$, which is 2.5 times less than after aging of the alloy with the usual regime ($5.65 \cdot 10^{-5}$). Relaxation stability under conditions of cyclic loading also increases 2.5 times.

Therefore, to improve the accuracy, reliability, and life of instruments, it is suggested to subject elastic elements made of bronze BrBNT1,9Mg to two-stage aging under stress by the following regime: 210°C 1 h at σ = 100 MPa + 340°C 1 h at σ = 200 MPa.

The suggested procedure of aging may be used efficiently for treating elastic elements made of other brands of bronze, too.

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