CONCLUSIONS

1. Chemicothermal treatment markedly increases high-temperature strength characteristics, but ductility is reduced.

2. The level of vacuum has a marked effect on creep and stress-rupture strength characteristics for niobium alloys not subjected to CTT.

3. Creep and stress-rupture strength characteristics of niobium alloys subjected to CTT in high and ultrahigh vacuum practically coincide.

LITERATURE CITED


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STRUCTURAL-STRENGTH CHARACTERISTICS OF ALLOY D16T SHEET WITH A REDUCED COPPER AND MAGNESIUM CONTENT

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One way of increasing the resistance to failure of aluminum structural alloys is a reduction in the content of iron and silicon impurities, and also addition of basic alloying elements below a level within the limits of the standard [1-4].

In the present work from the results of tests on 43 specimens mechanical property characteristics \( \sigma_{0.2} \), \( \sigma_f \), \( \delta \), fracture toughness \( K_C \), \( K_f \), residual strength \( \sigma_{\text{net}} \), and fatigue crack growth rate (FCGR) have been evaluated using statistical treatment; low-cycle fatigue resistance (LCF) and multicycle fatigue resistance (MCF) have been evaluated for plated sheets of alloy D16T 1.85 mm thick from one melt prepared under industrial conditions with contents of alloying elements such as copper and magnesium close to their lower levels. The chemical composition of the test alloy D16T sheet, wt. %, is as follows: Cu - 4.17; Mg - 1.20; Mn - 0.61; Fe - 0.44; Si - 0.34; Ti - 0.037; Ni - 0.044; Zn - 0.062.

These specimens were cut in the longitudinal direction. Mechanical properties in tension \( \sigma_{0.2} \), \( \sigma_f \), and \( \delta \) were evaluated in specimens with a gauge length of 5.65 \( \sqrt{F} \) (F is the cross-sectional area).

Fatigue crack growth rate, and also fracture toughness characteristics \( K_C \) and \( K_f \), as well as residual strength \( \sigma_{\text{net}} \) were determined in tensile tests on specimens with width \( W = 200 \) mm, length 600 mm, and a central through-notch of original length \( 2l_0 = 10 \) mm, width 0.5 mm, and radius of curvature 0.25 mm.
<table>
<thead>
<tr>
<th>Property</th>
<th>Average</th>
<th>Maximum</th>
<th>Coefficient of variation</th>
<th>Confidence range for $X_0$</th>
<th>Lower guaranteed level of $X_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma_{0.2}$, MPa</td>
<td>316</td>
<td>19.3</td>
<td>6.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$\sigma_f$, MPa</td>
<td>459</td>
<td>12.7</td>
<td>2.76</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$\delta$, %</td>
<td>20.8</td>
<td>1.30</td>
<td>6.27</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$\sigma_{\text{net}}$, MPa</td>
<td>329</td>
<td>10.4</td>
<td>3.18</td>
<td>326...333</td>
<td>299</td>
</tr>
<tr>
<td>$K_c$, MPa$\cdot \sqrt{m}$</td>
<td>101</td>
<td>4.8</td>
<td>4.76</td>
<td>100...103</td>
<td>87.5</td>
</tr>
<tr>
<td>$K_f$, MPa$\cdot \sqrt{m}$</td>
<td>77.2</td>
<td>2.5</td>
<td>3.27</td>
<td>76.2...78</td>
<td>70</td>
</tr>
</tbody>
</table>

*With a confidence level $P = 95\%$.
†With a confidence level $P = 95\%$ in 99% of the cases.

Fig. 1. Histograms for values of residual strength $\sigma_{\text{net}}$ and fracture toughness characteristics $K_c$ and $K_f$ plotted from the results of testing 43 D16T alloy sheet specimens.

Fig. 2. Dependence of the increase in fatigue crack length on the number of loading cycles for 43 alloy D16T sheet specimens.

During growth of a fatigue crack 35 mm long from each side of the notch with a maximum initial cyclic stress $\sigma_{\text{max}} = 98$ MPa and a cycle asymmetry coefficient of 0.1, a record was made of the overall value of increase in fatigue crack length from both sides of the original notch as a function of the number of cycles $2\Delta l - N$. From the $2\Delta l - N$ curve obtained a fatigue failure diagram was plotted: the dependence of fatigue crack growth rate on stress intensity factor amplitude on double logarithmic coordinates $\log(2l/dN) - \log AK$.

Tests with the aim of determining $K_c$, $K_f$, and $\sigma_{\text{net}}$ were carried out with single-stage extension of specimens with an original fatigue crack $2l_f = 0.4W$ long with a record of load as a function of the displacement of the crack edges ($P-V$). Effective crack length $2l_c$ with the maximum load necessary to calculate the critical value of stress intensity factor $K_c$ was determined from yielding for specimens with a crack on the basis of the procedure given in [5].

The critical value of stress intensity factor $K_c$ was calculated by the equation

$$K_c = \frac{P_{\text{max}}}{W \cdot t} V l^1.77 \left[ 1 - 0.1 \left( \frac{2l}{W} \right) + \left( \frac{2l}{W} \right)^2 \right],$$

where $P_{\text{max}}$ is the maximum load; $W$ and $t$ are the specimen width and thickness, respectively; $2l_c$ is the effective critical crack length equal to the sum of the original fatigue crack length $2l_f$, precritical increase $2\Delta l_c$, and extent of the plastic deformation zone from both sides of the crack $2r_f$. 

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