EVALUATION OF FATIGUE DAMAGING BY CHANGES MODULUS DEFECT MEASURING

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Effective elasticity characteristics of metallic materials at a number of loading cycles show corresponding structural changes due to the growth of dislocation density and their interaction. A brief description of amplitude, temperature and cycling influence on metals and steels modulus defect is given.

INTRODUCTION

Measurements of elasticity modulus E and G of annealed pure metals and carbon steels are done at reversion torsional pendulum (1 Hz) and at resonance system during cross-sectional (1 kHz) and longitudinal (23 kHz) oscillations of specimens.

Amplitude dependences of metal modulus defect are determined by certain laws (Fig. 1). Curves \( \Delta E/E - \ln \varepsilon \) show two linear regions with different intensity of modulus defect. The second and more intensive section of the curve has taken place at \( \varepsilon > \varepsilon_{cr} \). \( \varepsilon_{cr} \) corresponds to the appearance of microplastic hysteresis at strain cycling (1). Modulus defect has taken place at temperature higher than \( T_{cr} = (0.35-0.4) T_{melt} \). With the growth of \( \varepsilon_{T_{cr}} \) decreases and modulus defect increases.

Dislocation mechanism of microplasticity is developed at \( T > T_{cr} \). Activation energies were calculated. From \( \Delta E/E = (B \cdot \varepsilon^{1-n})^n \) parameters of fatigue were determined (1).

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Table 1 - Comparison of Values of Material Constant B and Cycle work-hardening Coefficient n.

<table>
<thead>
<tr>
<th></th>
<th>Cu</th>
<th>Al</th>
<th>Fe</th>
<th>Mo</th>
<th>Nb</th>
<th>Ti</th>
<th>Steel (0.4 % C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ε Cr×10^4</td>
<td>0.8</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>10</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>n</td>
<td>0.63</td>
<td>0.5</td>
<td>0.48</td>
<td>0.5</td>
<td>0.2</td>
<td>0.36</td>
<td>0.32</td>
</tr>
<tr>
<td>B</td>
<td>0.73</td>
<td>0.3</td>
<td>0.33</td>
<td>0.51</td>
<td>0.02</td>
<td>-</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Fig. 2 shows ε influence on ΔE/E of iron under different loading conditions (I-III). Quick loading was tested for 3 min., slow 15-20 min. Other specimens were loaded at different amplitude of deformations N = 2.10^6 cycles (III). Cumulative damage processes characterised by curves ΔE/E lnN depend on the cycle amplitude deformation value.

REFERENCES

Figure 1 Amplitude and temperature influence

Figure 2 Strain cycling influence