Measurements of the Young modulus normalized yield stress and the stress sensitivity parameter in creep of the Zr + 4.5% Sn + 1% Mo alloy in the temperature interval 300 K — 750 K are presented. It is shown that there exists a plateau in the temperature dependence of the Young modulus normalized yield stress in the temperature range 540 K — 660 K. The stress sensitivity parameter and the activation area exhibit a maximum at about 550 K. The discontinuous creep deformation is observed. It is suggested that the dynamic strain aging plays a significant role in the creep deformation of the Zr + 4.5% Sn + 1% Mo alloy in the temperature interval 540 K — 660 K.

1. INTRODUCTION

The plastic deformation of zirconium and its alloys has been fairly studied due in part to the technological importance of these materials in reactor design. Soo and Higgins [1] and Ruano and Elsner [2] suggest a change of the thermally activated mechanism in alpha-Zr at about 300 K. Ramaswami and Craig [3], Mills and Craig [4], Kudláček and Hamerský [5] have observed such a change at about 600 K, while Baldwin and Reed-Hill [6] and Sastry et al. [7] have proposed a single mechanism in the whole temperature interval from 77 K to 700 K.

The purpose of the present work was to study some creep characteristics of the Zr + 4.5% Sn + 1% Mo alloy in the temperature interval 300 K — 750 K, that means in the interval where anomalous behaviour of zirconium has been observed.

2. MATERIALS AND EXPERIMENTAL PROCEDURE

The samples of the Zr + 4.3wt% Sn + 0.95wt% Mo alloy of gauge length 50 mm and diameter 2.1 mm were prepared at the Institute of Physical Metallurgy of the Czechoslovak Academy of Sciences in Brno. The preparation of specimens is described elsewhere [8]. The average grain size of specimens after special metallurgical treatment was about 0.3 mm. All experiments were carried out in an argon atmosphere. The incrementally loading method [9, 10] was used.

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3. Results

During the creep tests the static Young modulus $E$ and the stress sensitivity parameter $n$ were measured by means of differential stress technique. The temperature dependence of the Young modulus normalized yield stress is shown in fig. 1.

![Fig. 1. The temperature dependence of the Young modulus normalized yield stress.](image)

While Young’s modulus is roughly monotonously decreasing the yield stress exhibits a plateau in the temperature interval $540\text{K} - 660\text{K}$. Such a dependence is in good agreement with the results obtained by other authors [4, 11], and can be explained by means of the dynamic strain aging [12].

The stress sensitivity parameter $n$ was evaluated by means of the relation

$$n = \frac{\ln(\dot{\varepsilon}_2/\dot{\varepsilon}_1)}{\ln(\sigma_2/\sigma_1)}$$

where $\dot{\varepsilon}_i$ is the strain rate for the applied stress $\sigma_i$ ($i = 1, 2$). The results of measurements obtained are demonstrated in fig. 2. For all measurements (except for the highest used temperature) the stress independence of the stress sensitivity parameter

![Fig. 2. The stress and temperature dependences of the stress sensitivity parameter $n$.](image)