**Letters to the Editor**

**References**


**RATE OF PROPAGATION OF PLASTIC DEFORMATION IN THE LÜDERS BAND**

The model of the propagation of the Lüders band during the deformation of α-iron polycrystals at the lower yield stress is based on the assumption that plastic strain occurs only in front of the Lüders band [1]. The part of the specimen in front of the Lüders band is deformed only elastically. The plastic strain of the specimen behind the Lüders band is equal to the Lüders strain. The deformation of this volume during elongation does not continue at the lower yield stress. From this model the average strain rate $\dot{\varepsilon}_L$ in the Lüders band can be deduced as [2]:

$$\dot{\varepsilon}_L = \frac{v}{w}$$

where $v$ is the crosshead speed and $w$ is the width of the Lüders band.

The plastic strain rate $\dot{\varepsilon}$ in the flow stress region beyond the Lüders strain is given by

$$\dot{\varepsilon} = \frac{v}{L} \left( 1 + \frac{d\sigma}{d\varepsilon} \right) \frac{F}{ML}$$

where $L$ is the gauge length of the specimen, $F$ its cross-section, $M$ the rigidity constant of the testing machine and $d\sigma/d\varepsilon$ the work-hardening rate of the material.

It is clear that the plastic strain rate in front of the Lüders band during deformation must be greater than in the flow stress region beyond the Lüders strain. Hence:

a) Friction stress in the Lüders band is greater than that in the flow stress region beyond the Lüders strain (Fig. 1 point A, B resp.).

b) The configuration of dislocations in α-iron strained at the lower yield stress must be different from that beyond the Lüders yield.

Specimens from low carbon steel (content 0.07% C, 0.28% Mn, 0.01% Si, 0.21% P, 0.0021% N, 0.0178% O; grain size $d = 0.05$ mm, annealed) were used for the experiments. The length of the specimens was 70 mm, the crosshead speed 1.2 mm sec$^{-1}$.
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The majority of methods for determining friction stress are based on the assumption that the flow stress $\sigma$ can be written as

$$\sigma = \sigma_0 + \sigma_\mu$$

where $\sigma_0$ is the friction stress, which is in general a function of the strain ($\varepsilon$), strain rate ($\dot{\varepsilon}$) and temperature ($T$). $\sigma_\mu$ is that part of the flow stress that depends only on the strain ($\varepsilon$) and grain size ($d$), and it depends on the temperature through elastic constants only.

The methods for friction stress measurements can be divided into two groups. The first group assumes that $\sigma_0$ is constant during deformation. Then the course of the stress-strain diagram is given by the dependence $\sigma_\mu = f(\varepsilon, d)$. The value of $\sigma$ is then determined from equation (3) by extrapolation of the $\sigma_\mu = f(\varepsilon, d)$ dependence to zero. In such a way the friction stress in front of the Lüders band and in the flow stress region beyond the Lüders strain was determined in [2] for the same material. The difference between these two values of the friction stress was 4 kp/mm$^{-2}$.

The second group of methods makes it possible to measure the friction stress during deformation and assumes the validity of equation (3) for definite strain only. The friction stress is determined by small changes of a suitable mechanical characteristic (unloading curve, creep, stress relaxation [3—5] etc.) in a certain point of the stress-strain diagram. By the method of inverse relaxation of stress [5] the same difference in friction stresses as above (Fig. 1) was found. Experiments [2, 5], which gave different values of the friction stress were performed with the strain rate $3 \times 10^{-4}$ sec$^{-1}$. From the dependence of the external stress on the velocity of loading [6] it can be seen that the measured increase in friction stress in front of the Lüders band is equivalent to the strain rate $\dot{\varepsilon} \approx 10^{-2}$ sec$^{-1}$.

A detailed study of changes of dislocation structure [7] shows a strong dependence on temperature. An increase in strain rate has the same influence on the dislocation distribution as a lowering of the temperature [8]. The increase of strain rate deduced from friction stress changes should be sufficient for a strong change of dislocation structure. Figure 2 (Appendix III, p. 98c) shows the dislocation arrangement in that part of the specimen which was plastically deformed at a lower