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Experimental Analysis of Deformation by the Sliding Strips Method

Experimentálna analýza deformácií metódou sklzových pásov

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Abstract: The density of sliding strips, i.e. the height and the number of degrees, increases according to the amount of deformation. The sliding strips method is based on the assumption that the sliding strips heights $(\Delta\nu)$ of one shot are equal to their displacement in the direction of a maximum shearing stress. Provided that the sliding is performed in the plane τ_{max}, we will calculate a local absolute deformation. This is a significant and accurate method which has been verified in domestic conditions and abroad.

Keywords: sliding strips method, deformation, sliding strips density, static load, dynamic load, tension, pressure

1. The method description

Plastic deformation manifests itself in the amount and density of the sliding strips in connection with dislocations [1,2,3].

Each dislocation, which abandons the polished surface of metal, leaves on it a degree equal to the height of the Burgers vector of the related dislocation considering the angle of the sliding plane. The height and the number of degrees increase in accordance with the increment of the linear deformation amount. Providing that the plastic deformation of the shot in the direction of a maximum sliding stress effecting is homogeneous, all the sliding strips will be visible on the surface. The method is also suitable for larger deformation $\varepsilon > 10\%$.

The sliding strips method of one shot is based on the assumption that the heights $(\Delta\nu)$ of the sliding strips of one shot will be equal to their displacement in the direction of a maximum shearing stress (fig. 1).

If the sliding is performed in the plane with τ_{max} ($45°$ according to Schmid-Boasa), the absolute deformation can be calculated.

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$$\Delta L = L - L_0 = \sum \Delta L_i \cdot tg\alpha = \sum \nu_i \tag{1}$$

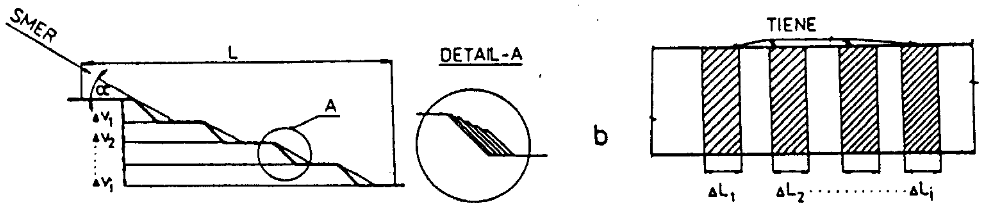

fig. 1
Diagram of the sliding strips configuration

Hence,

$$L_0 = L - \sum \Delta L_i \cdot tg\alpha \tag{2}$$

Then the unit linear deformation

$$\varepsilon = \frac{\sum_{1}^{n} \Delta L_i \cdot tg\alpha}{L_0} \cdot 100\% \tag{3}$$

This does not mean, however, that the amount of the unit linear deformation is proportional to the number of the sliding lines in configurations.

2. Deformation evaluation by the sliding strips method

By the help of the sliding strips configuration we observed the distribution and the degree of plastic deformation inside the surface layers after both the dynamic and static load had been applied with the same conditions as with the dislocations observation. The sliding strips configurations were investigated through the specimens of ∅ 15 x 22 mm with the polished stripe 3 mm wide on the cylinder area as well as on the axial polished hole of ∅ 2 mm after the longitudinal cutting had been done.

After the dynamic load, the sliding strips configurations inside the surface layers perform a high degree of concentration, often in various directions and along the entire contact layer. After the static load, the sliding strips configuration inside the surface layers show a small density in a small number of shots. The least number of deformed shots occurs after the static loading in the stagnation area. The sliding strips density inside ferrite was observed by the line electronic microscope JSM – 50A.

The sliding strips from the surface layers of ferrite obtained from the polished strips on the specimens after dynamic and static deformation can be seen in fig. 2 a, b.

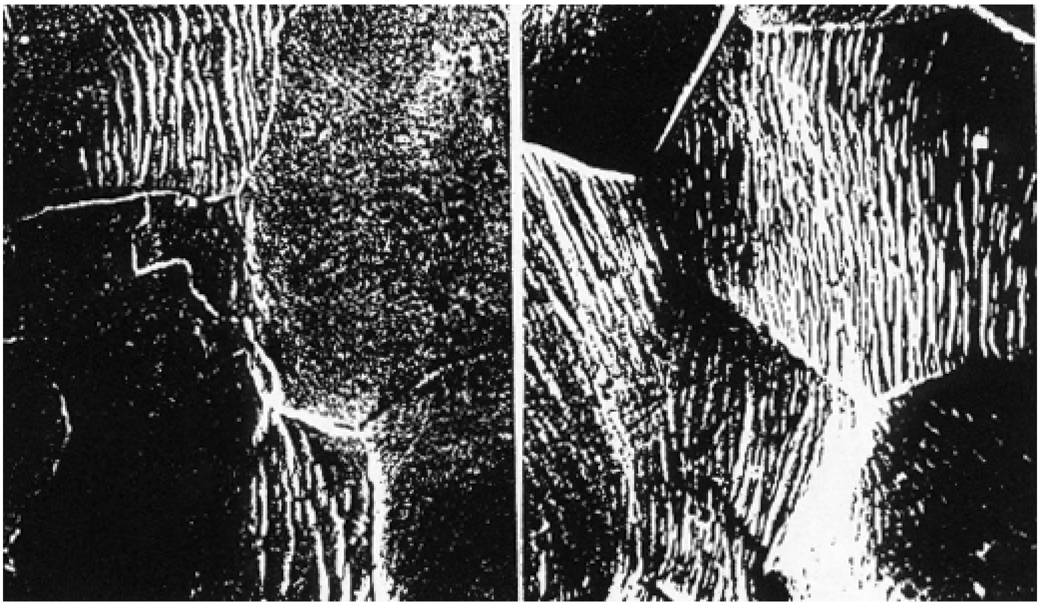

Fig. 2 a, b
Sliding strips with cold shaping
$a-\varepsilon_S = 10\%$, $b-\varepsilon_D = 10\%$ (2000 x)

The sliding strips density after the deformation in ~ 30% remained even after the tension test inside the warm vacuum chamber (550°C) of the line scanning microscope ELINOIKS – 330S, fig. 3. Microtension specimens were deformed statically ($10^{-3}s^{-1}$) and dynamically ($10^{3}s^{-1}$) with cold shaping and metallographically polished. It was proved that, after the dynamic load, the assumed dislocation network manifested a significant heat stability and even after the recovery it preserved relatively the highest hardening.

The sliding strips density before fracture for dynamically and statically preliminary deformed specimens are presented in fig. 4 a, b and fig. 5 a, b.

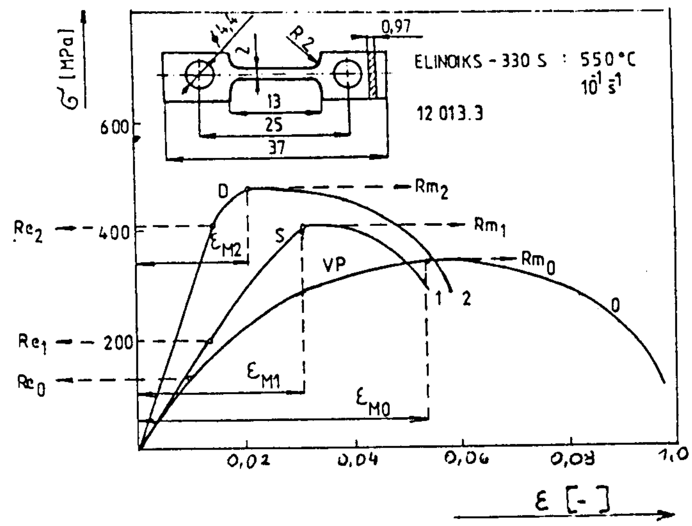

Fig. 3
Registration tension diagrams Armco Fe
O – basic material, $2-\varepsilon_D = 28\%$, $1-\varepsilon_S = 30\%$

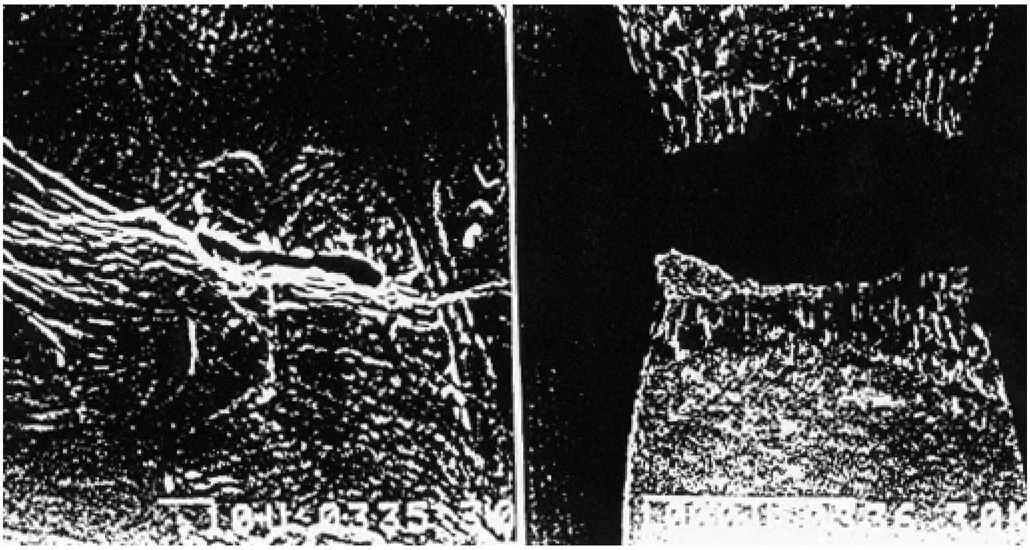

Fig. 4 a, b
Sliding strips with hot shaping (550°C), $\varepsilon_D = 28\%$
a – before failure, b – failure (100x, 3x)

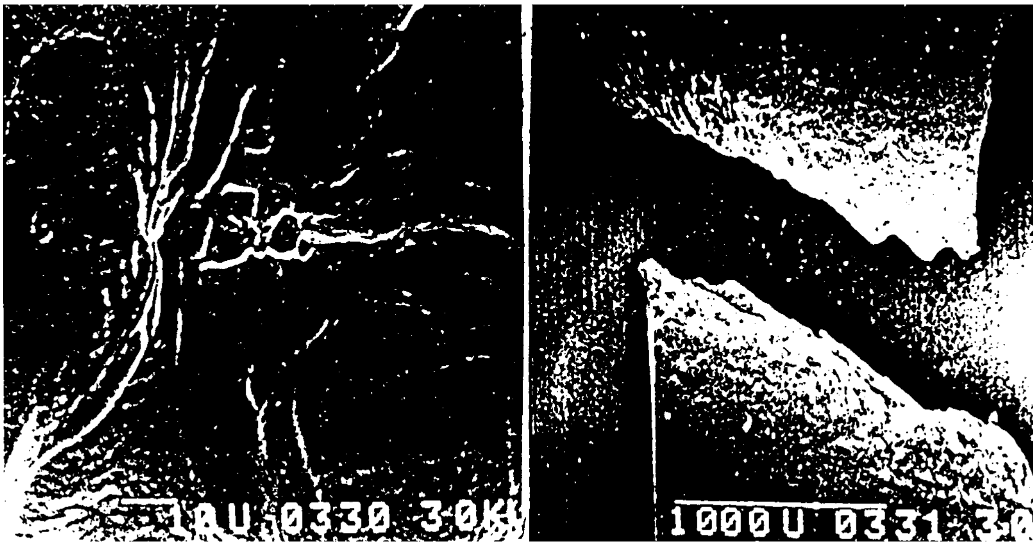

Fig. 5 a, b
Sliding strips with hot shaping (550°C), $\varepsilon_S = 30\%$
a – before failure, b – failure (1000x, 3x)

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