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COMPUTER SIMULATIONS OF MAGNETOPLASTICITY IN NONMAGNETIC MATERIALS

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ABSTRACT

Magnetoplasticity in nonmagnetic crystals is a very peculiar phenomenon discovered by the experimental group of the second author. It was found [1, 2] that dislocations in alkali halides and metals under the field $B \sim 1$ T, in the absence of loads or any other external actions, moved at macroscopic distances $l \sim 10 \div 100$ μm. Then this phenomenon was studied in details by the same group and by many independent researchers (see e.g., review article [3]). The effect manifests itself in a remarkable change of a pinning force on dislocations from point defects under external magnetic field. This change is caused by an elimination of quantum exclusion of some electron transition in the system impurity-dislocation due to an evolution of a spin state in this system under the influence of a magnetic field. After the above transition a configuration of the pinning center becomes completely different and the pinning force also changes. As a rule this leads to a softening of crystals, however for some specific choice of doping there are also known examples of their strengthening. In the computer simulations of

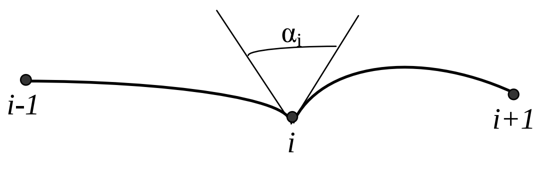

Figure 1: An angle between tangents to the dislocation segments

the MPE it was accepted that if the angle α between two neighbor arcs (the angle between the tangents to the arcs at the same pinning point), exceeds the critical value α_c related to the force by the relation

$R = \dfrac{\Gamma}{\sigma\, b}$, where R – curvature radius, Γ – line tension, σ – driving stress, b – Burgers vector, then the given obstacle cannot hold the dislocation (Fig. 1).

The action of the magnetic field and the thermal fluctuation can significantly lower the value of α_c and the dislocation can move more easily.

In our computer simulations we were especially interested in distributions of dislocation segments lengths on stationary moving dislocations, in characteristics of unzipping processes and in typical numbers of active pinning points on a dislocation when it moves under the magnetic field. Fig. 2 shows some hidden data of this sort obtained from the computer experiments.

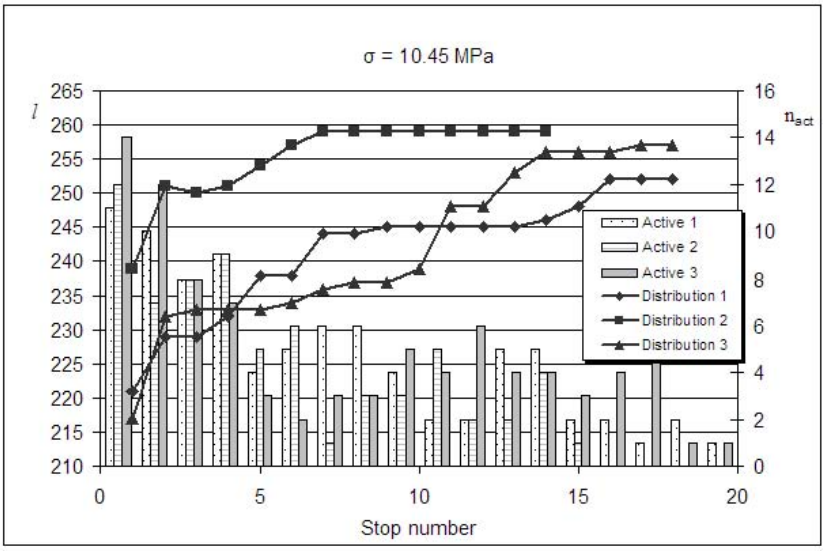

Figure 2: The distance made by the left end of the dislocation and the number of active obstacles on the dislocation line at each its stop for the three realizations of point defect distribution at the fixed external driving stress $\sigma = 10.45$ Mpa

For every stop of the dislocation line the number n_{act} of active stoppers was counted. On the left ordinate axis the distances between the separate stops of the surface dislocation end are given. On all three curves one can see the horizontal regions where the number of active centers on the dislocation line is substantial. This means that even on this regions some internal dislocation motions continue.

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