05.2-12 EVOLUTION OF THE DISLOCATION STRUCTURE OF THE HIGH-PURITY DEFORMED Mo SINGLE-CRYSTALS DURING THE SOFTENING PROCESS. L.N.Pronina, I.M. Aristova, Institute of Solid State Physics, Academy of Sciences of the USSR, Chernogolovka

High-purity Mo single-crystal (RRR=140000) rolled to ε =90% and annealed at 2000°C was investigated. In previous studies (001) [110] Mo crystals (with RRR=1000) were shown to retain the single-crystal structure at all the stages of deformation and also after continuous high-temperature annealing. The sub-boundaries in the annealed crystals

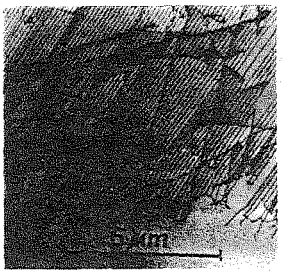

Fig.1.

(Fig.1) consist of equally spaced straight dislocations with $\bar{b}$=[001] parallel to the rolling direction (L.N.Pronina, S.Takeuchi et al., Phil.Mag.A, 1982, vol.45, N 5, 859-865). The dislocation structure annealed high-purity single-crystal is characterized by formation of a typical annealing structure with predominating edge dislocations with $\bar{b}$=[001] already after 10 sec at 2000°C (Fig.2). But after 20 sec and 30 sec annealing the structure changes drastically, that is, along straight edge dislocations with $\bar{b}$ = [001] there arise helical "local defects" (Fig.3) which are likely to be induced by diffusion of point defects, rather than of impurities, since the crystals were perfectly chemically pure. Further development of the structure (40 sec) shows growth of "local defects" with subsequent formation of a network of dislocations with Burgers vector $\bar{b}$=[111]. The similar dislocation network was observed at the initial stages of annealing (10 sec) Mo single crystals with RRR=1000 (I.M.Aristova, L.N.Pronina, Proc.Tenth Europ.Cryst.Meeting, p.599, 1986). The fact that at this stage the annealing structure of such crystals does not exhibit any parallel edge dislocations with $\bar{b}$=[001] is caused probably by the impurities, which affect essentially the way of its formation. After annealing at 2000°C for 3 min, a typical annealing structure can again be observed in highly pure crystals and is retained steadily under subsequent annealings (up to 2 hrs). In this case elongated parallel edge dislocations with $\bar{b}$=[001] predominate in sub-boundaries (Fig.4).

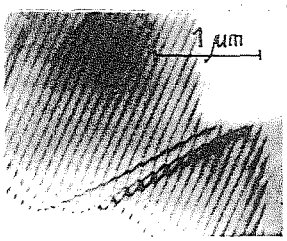

Fig.2.

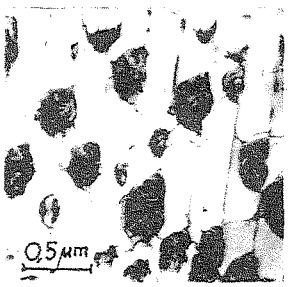

Fig.3

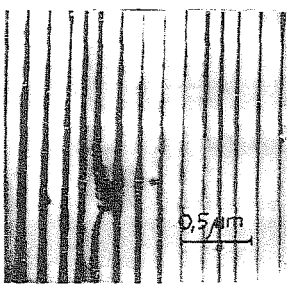

Fig.4.

05.2-13 EFFECT OF THE INITIAL PREFERRED CRYSTALLITES ORIENTATION ON FRACTURE MECHANISM IN HEXAGONAL METAL. ANOMALOUS FAILURE BEHAVIOR PREDICTED BY SIMPLE MODELS BASED ON NEUTRON DIFFRACTION RESULTS. By R. Nowak, Institute of Physics and Nuclear Techniques, University of Mining and Metallurgy, Cracow, Poland.

The elements of microstructure of the materials which prove to be significant for mechanical behavior and frequently involve some unexpected effects are not so far entirely recognized. The purpose of study presented, has been to investigate the correlation between the initial crystallographic texture and failure process.

A simple model predicting the anomalous mechanical behavior of polycrystalline metal, based on results of neutron diffraction texture determination method and also on the single crystal properties, has been proposed. The calculations have been done for pure zinc, but the choice of material does not limit the broadness of the approach. Four single crystal orientations which coincide with the sharp maxima of the texture, have been used as the first approximation of the polycrystal. In order to estimate a behavior of metal occuring later under the applied uniaxial stress, the relative probability of various slip systems activation has been found as a function of θ-angle between rolling direction on the pole figure and the tensile force vector. As the obtained results showed, within a certain θ-angle-interval, the activation probability for basal slip systems is lower than that of the others. In this case, an anomalous mechanical behavior of textured material is expected.

The model of a real material - the polycrystalline aggregate defined as a number of noninteracting, identical, hexagonal crystals with preferred orientations - has been proposed on the basis of measured texture pole figures. Each single crystal has been considered as an anisotropic continuum without structure, but with elements of symmetry of the appropriate unit cell. Only the initial stages of the aggregate deformation process, under the applied stress, have been taken into consideration. The regular Hooke's law based procedure and the calculations with the assumption, that elastic deformation is due to reversible displacement of anchored dislocations, have been used to obtain the strain values. The curves of strain vs. θ-angle suggest anomalous behavior of metal for certain directions of applied tensile force.

The experimental results of the tensile and the 3-point bend impact tests have been obtained on specimens cut in various directions from rolled pure zinc sheet. The texture examinations have been performed by means of a neutron diffraction which is more suitable than the X-ray method and is the only way when considering failure phenomena where the bulk material information is required. The micromechanism of fracture of each sample, has been determined by the use of SEM-technique.

The experiments proved certain anomalies, i.e. post yield brittle fracture of zinc at room temperature (Fig.1) and unexpected crack propagation phenomena in the metal.

The anomalous fracture properties have been observed only in the case of specimen orientations predicted by proposed theoretical model.

Despite the fact that only elastic deformation and initial texture have been theoretically considered, further conclusions regarding fracture and failure processes appeared to be surprisingly consistent with experimental data.

Thus a distinct and significant influence of crystallographic texture on failure process has been confirmed.

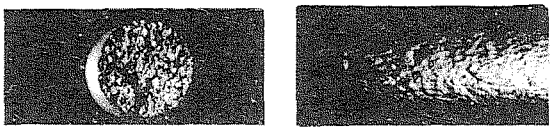
Fig.1. General view of failured zinc specimens:
left - anomalous fracture, orientation predicted by model
right - typical view of failured sample