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ELECTROPLASTIC EFFECT AT TWINNING METALS

Use of pulses of a current of high density, electric and magnetic fields, ionic implantation have allowed to intensify plastic deformation of metals, thus, giving a basic opportunity of management of plastic deformation twinning with the help of forces of the nonmechanical nature, influencing on conditions and character of hardening of a material by means of controllable twinning.

Fundamental and applied problems of modern materiology on increase of a production efficiency, and increase of its technological level are defined by necessity of creation of a complex of high physicomechanical properties of materials for extreme physical conditions with high service characteristics. The basic kinds of plastic deformation of crystal bodies are sliding and twinning. In spite of the fact that twinning concerns to the basic kinds of deformation of crystals, as against the sliding, the given kind of plastic deformation is investigated insufficiently full, at the same time experimental results on studying twinning prove to be true opening all the new phenomena proceeding at the given kind of deformation. Deformation of metals in conditions of low temperatures and the big speeds load results in fragile destruction of that processes of plastic deformation have not time to be realized. Therefore studying of processes of plastic deformation twinning is an actual task, both in scientific, and in the applied plan [1].

Realization twinning is carried out in a case an interdiction for usual disposition slidings, and also at the big speeds load and at low temperatures. Sources of generating twinning dispositions are concentrators of tension, and development of doubles is carried out with the big speeds and the subsequent deformation processes on borders of doubles frequently result in destruction of a material. In this connection management kinetics controllable twinning, for creation uniform disposition structures on borders of doubles with the purpose of reduction in concentration of load, gives a real opportunity to use twinning as a reserve of increase of plasticity of a material. On the other hand systems of thin doubles at the subsequent deformation will create natural obstacles for full dispositions, in this connection creation in a material twinning structures probably effective hardening of a material that is independent way and the channel of hardening twinning metals.

At pass through metal monocrystals of impulses of an electric current with density from 50–1000/mm^2 and duration 10^{-4} with, deformation redistribution twinning in vicinities of concentrators of mechanical pressure is observed.

Comparison of pictures of deformation with an impulse of a current and without an impulse shows, that at joint action of electric and mechanical pressure there is a stimulation of plastic deformation twinning.

At action on a crystal of the concentrated loading occurrence of doubles is provided with excitation of dot sources twinning dispositions. twinning germs have double wedge, their development follows the bill of simultaneous moving of regional making dispositions in a plane of shift and screw in a plane unity. Such doubles can arise in volume of a deformable material near to concentrators of pressure at any kind loading.

One of features of development of the doubles arising "in a point", is the sequence of elementary certificates of development: at short-term action of

loading there is a thin double of final length, at increase in time of action indentor on a crystal generating twinning dispositions and their translation on borders of section without increase in length twin a wedge is observed. It is natural, that moving from a mouth to top twinning dispositions can meet an obstacle and form a congestion. Thus will sharply increase incoherent twins borders in planes (III), and internal pressure can lead to disclosing of cracks in a secondary plane unity.

At pass a current impulse through a crystal during deformation the new kind of interaction screw twinning dispositions with an obstacle is observed. Excitation of an electronic subsystem of the sample leads to intensive reproduction twinning dispositions on borders of section and to collective interaction screw making twinning dispositions with an obstacle. As a result there is a phenomenon of branching of doubles not observed earlier.

Branching of doubles arises always on curve borders of section, where degree incoherent twinning borders the greatest.

Doubles usually arise on congestions and relaxations of internal pressure at a print lead. Till now it was known, that the relaxation of internal pressure can be carried out at the expense of sliding development, for example, in the areas of a crystal adjoining to twinning to borders. In the given job for the first time it is revealed, that under the influence of electric impulses the relaxation of internal pressure is carried out as a result of development of new doubles, and new doubles arise not only on congestions of full dispositions, but also on borders twinning layers, i.e. on congestions twinning dispositions. Doubles, arising in places of concentration of pressure, discharge dislocation congestions, thereby reduce probability of fragile destruction in reintense places of a crystal lattice.

In absence of external power influences "branchy" doubles arise on twins borders with small degree coherent (fig. 1) is more often.

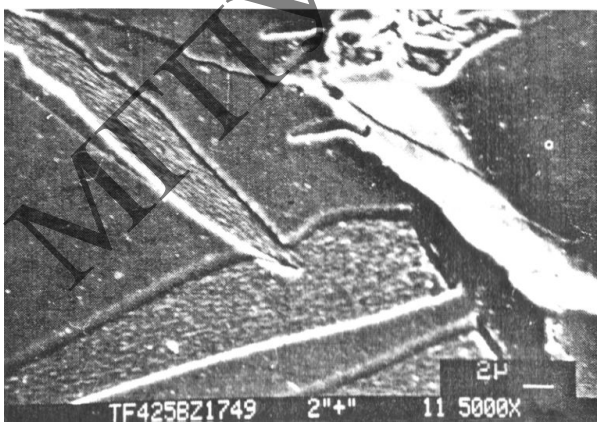

Fig. 1 – Origin of the double on twin to border with small degree coherent

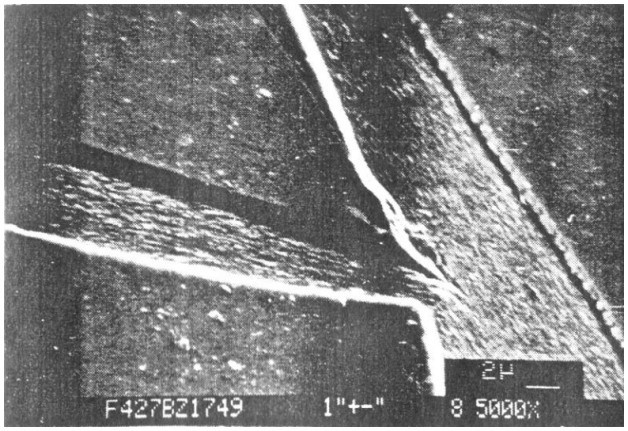

Fig. 2 – Branching of the double at a stopper

The curvature twinning borders is called by superfluous concentration on them twinning dispositions. The raised density of dispositions on twin to border conducts to localisation on it of the internal pressure which sources are twinning dispositions. Thus in places of a congestion of dispositions there can be pressure comparable on size with an occurrence threshold aspect wedge the double. The relaxation of the given pressure occurs through origin on twin to border of the new double which develops in a new energetically favourable direction (fig. 2).

The picture of fields of pressure at aspect wedge the double (fig. 3) which is received in the assumption of is considered that twin the border consists from full [1, 3], instead of partial dispositions. Fields of pressure round a congestion of such dispositions of looking like wedge can be calculated under the formula:

$$\sigma_{xy} = \frac{Gb}{2\pi(1-\nu)}\left\{\sum_{n=0}^{N_1}\frac{(x+nd)[(x+nd)^2-(y+nh)^2]}{[(x+nd)^2+(y+nh)^2]^2}\right.$$

$$\left.+\sum_{n=1}^{N_2}\frac{(x+nd)[(x+nd)^2-(y-nh)^2]}{[(x+nd)^2+(y-nh)^2]^2}\right\},$$

where σ_{xy} – chopping off pressure, b – the module of vector Burgersa, G – the shift module, ν – factor Puassona, n – a summation index, N_1 and N_2 – number of dispositions on twin borders. In our case at the computer plotting, presented on fig. 3, it was accepted $N_1 = N_2 = 10$.

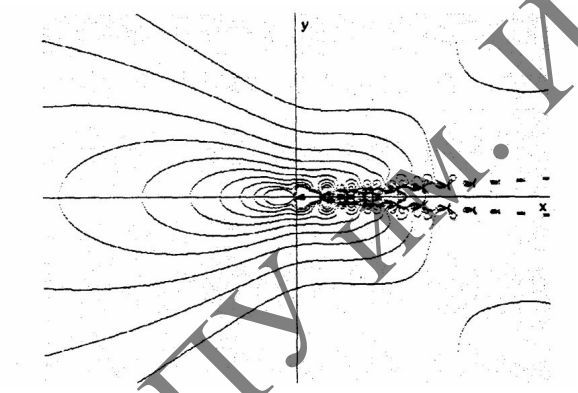

Fig. 3 – Fields of pressure at aspect wedge the double

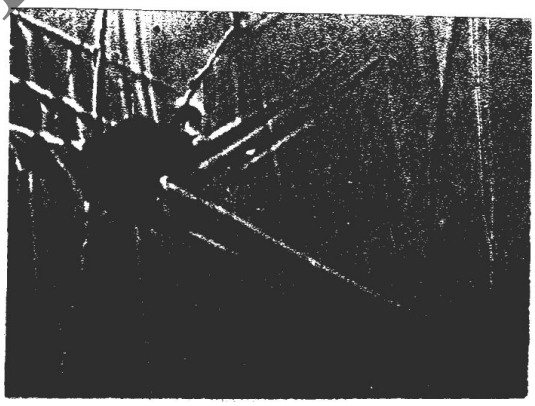

Fig. 4 – Education of the second top of the double in a crystal Be. Density of a current 700 А/мм^2; x 600

From fig. 3 it is visible, that pressure increase with approach to twin to border, moreover at top of the double they have the same order, as at direct affinity twin borders, but on dist aspect wedge ance in two-three times more. As a result in the presence of stoppers on a movement way aspect wedge the double, there is a redistribution of pressure at its top in such a manner that the size of their projections to a new direction twin becomes comparable with threshold value of occurrence of the double.

To stimulate dislocation processes at twinning crystals it is possible by pass through them of impulses of an electric current [2–5]. With growth of density of a current in an impulse generating processes twins dispositions amplify. Thus the collective moving on twinning to borders twinning dispositions can co-operate with an obstacle not only with education of the new double, but also overcome resistance of the stopped dispositions with education of the second top.

It is possible to explain stimulation by impulses of an electric current of branching of doubles also increase of internal pressure in a crystal at the expense of pinch-effect realisation. As a result of occurrence of additional pressure in a crystal the probability of occurrence of the second top of the double raises.

Thus, with the help elektroplastichesky a method of research and a method of computer construction of fields of pressure around aspect wedge the double it is established, that the relaxation of internal pressure in bismuth monocrystals can occur by realisation twinning at the expense of branching of doubles. And, the new top of the double arises not on full dispositions, and on partial twins.

The increase in time action indentor before pass a current impulse leads to density growth twinning dispositions on borders and to branching strengthening. Thus the density twinning on borders of section of each new generation of doubles is less than dispositions, than previous (fig. 4).

With growth of density of a current in an impulse generating processes twinning dispositions amplify. Thus the collective moving on twin to borders twinning dispositions can co-operate with an obstacle not only with education of the new double, but also overcome resistance of the stopped dispositions with education of the second top. On fig. 4 education of the second top of the double in a crystal Be is shown [6–9].

The described phenomena testify to additional possibility of plasticization mechanically twinning materials at creation in the course of deformation of the conditions favorable for reproduction twinning of dispositions. Such conditions can be created, passing through a material impulses of a current of the big density during deformation. Thus the relaxation of the internal pressure arising at dislocations of congestions on borders of section, can occur not only at the expense of education of new doubles therefore the reserve of plasticity increases and the probability of fragile destruction, but also as a result of partial intwinning decreases.

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