MS-20 oil, only the white unetched layer of high hardness is seen (Fig. 2,b); in the tests in oxygen atmosphere with the naphthene-paraffin fraction of the MS-20 oil (Fig. 2,c), the unetched white layer is relatively small.

Thus, in tests on the lubricating properties of oils, it is possible to estimate the effect of oil on the frictional surfaces by means of metallographic analysis.

DETECTION OF LOW-CARBON STEEL MICROSTRUCTURE BY ELECTROLYTIC POLISHING AND ETCHING

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A method of electrolytic polishing and etching for the preparation of a microsection of low-carbon steel of technical iron has been developed at our Institute.*

The microsections under test were first thoroughly polished by ordinary mechanical methods and then electro-polished for 2-3 seconds at 100 v and 0.015 a/cm^2 current density in an electrolyte consisting of a mixture of perchloric (5%) and glacial acetic acids. The cathode was of stainless steel. Subsequently, the section was subjected to electrolytic etching in methylalcohol solution of ferric chloride (0.5%) and hydrochloric acid (1.0%) at 16-20 v and 0.15-0.20 a/cm^2 for 3-6 seconds. The cathode was made of stainless steel.

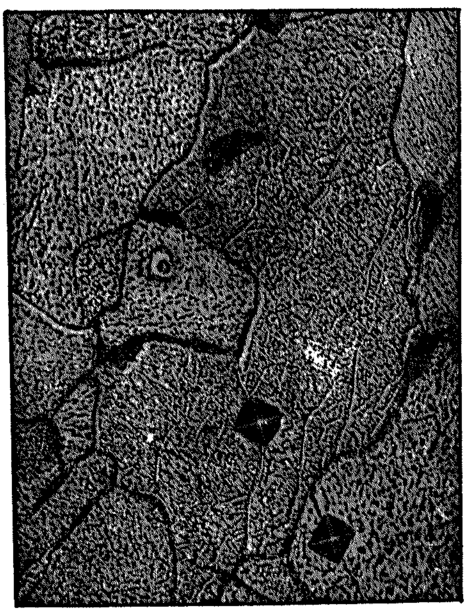

Fig. 1. Microstructure of technical iron after annealing. The boundaries of subgrains are clearly revealed in the center grain. ×1125.

The microstructure of technical iron after annealing (heated to 1000°C, kept for 1 hour at that temperature and then furnace cooled) is shown in Figure 1. The boundaries of the subgrains are clearly revealed in the central grain (the one with the indentation from the micro-hardness test). It should be pointed out that in work [1], it is recommended that electro-polishing in a solution of acetic and hydrochloric acid followed by etching with picric acid should be used for that purpose.

The tests, however, which we carried out showed that electrolytic etching provides a clearer exposure of the subgrain boundaries.

With the use of the above procedure, one can reveal quite clearly the features of a deformed microstructure. Figures 2-3 show microphotographs obtained during the metallographic study of notched impact-specimens of technical iron in a brittle condition at temperatures below t^0_{cr}. The experimental procedure has already been published [2].

In Figure 2, it is possible to follow the development inside the grain of the crack (1) which, on reaching the boundary of the subgrain (2), changed in direction, went along the boundary (3), and then went through the grain (4) again. Its further development, however, was prevented by local plastic deformation (5) which developed between the ends of two microcracks.

* G. I. Parfessa and V. A. Sidliarenko took part in the development of the procedure.

Fig. 2. A microcrack changing into local plastic deformation. The arrows indicate the boundary of subgrains. Technical iron. ×1125

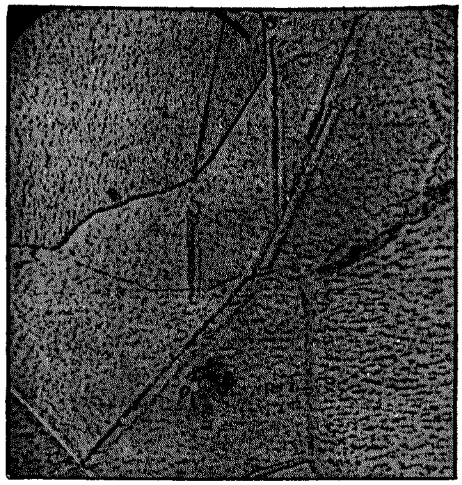

Fig. 3. Twin layers in technical iron: 1) a step, formed when a twin was stopped and displaced to the neighboring parallel plane. ×750.

Figure 3 shows the microstructure of grains containing a series of deformation twins. It is seen from the microphotographs that the etched shapes of the twins constitute a pattern in the form of a "herringbone", symmetrical and nonsymmetrical relative to the twin's main axis consisting of separate elongated spots. Similar etched patterns were observed on zinc twins in work [3].

The character of the etched patterns of twin layers is determined by the dislocations and the characteristics of plastic deformation during the twin formation. V. I. Startsev and V. M. Kasevich [4] succeeded in demonstrating by direct experiments that the twinning is accompanied by plastic deformation in the region which adjoins the twin and which is several times larger than the twin, itself.

LITERATURE CITED

[1] P. Samuel and A. Quarrell, J. of the Iron and Steel Inst. 182, 1, 20 (1956).

[2] B. S. Kasatkin, Izv. AN SSSR, OTN (Division of Tech. Sci.), No. 7, 75 (1955).

[3] I. Gilman, J. of Metals 8, 8, 998 (1956).

[4] V. I. Startsev and V. M. Kasevich, Fizika metallov i metallovedenie (Physics of metals and metallography, USSR) v. II, 2, 34 (1956).