Reduction of the current density to 0.05 amp/cm^2 after electropolishing made it possible to show up the grain boundaries of the iron base phase. Exposure to the electrolyte was reduced in proportion to the percentage of copper dissolved in the iron.

Figure 2 shows the microphotograph of a porous iron sample which had been etched for 10 minutes. The iron base phase etched strongly when a second phase was introduced into the composition. Figure 3 shows the microstructures of iron-copper compositions with different copper contents, obtained by the impregnation method. The time of electropolishing of all the microsections was 1 minute.

The iron-copper alloys, made by impregnating a porous structure of iron with liquid copper, or by sintering a compressed mixture of iron and copper powders in the presence of a liquid phase, usually consisted of two phases, if they contained more than 8% of copper. The polished surface of the section of such an alloy stood out in relief, since the rate of anodic dissolution of the copper base phase was greater than that of the iron base phase, so that the level of the former was always below that of the latter. In polishing a nonporous, single-phase, iron-copper alloy (with a copper content up to 8%), the polished surface obtained of purely copper or purely iron material was ideally flat.

Cold hardening, produced in the surface of a section by mechanical working and polishing, was completely eliminated by electropolishing.

Figure 4 shows the structure of the section of an iron-copper, metalloceramic, nonporous alloy, containing 23% of copper. At a magnification of 300 (a) the microstructure shows two phases: 1) a solution of copper in iron and 2) a solution of iron in copper. Figure 4 b shows an electron microphotograph of a collodion-titanium replica of the same microsection at a magnification of 5500.

The relief produced by electropolishing, as the result of the different rates of solution, made it difficult to strip off the replica, so that the two-stage replica method was used.

The apparatus described and the technique of electropolishing made it possible to obtain high-quality microsections of both porous and nonporous metalloceramic compositions with an iron-copper basis, over a wide range of composition.

ELECTROLYTIC SEPARATION OF MARTENSITE AND AUSTENITE FROM HARDENED STEEL

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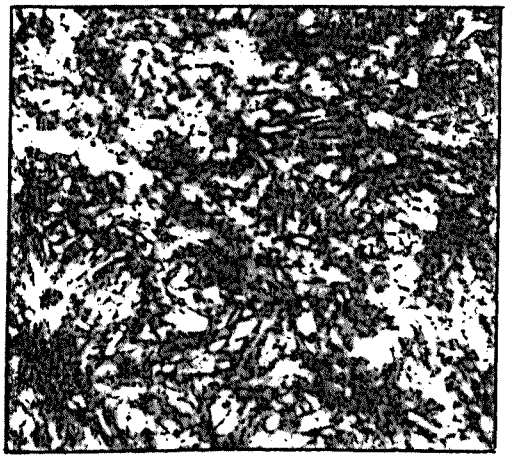
Investigation of the properties of martensite and austenite in polycrystalline samples is associated with difficulties in their determination, since the crystals of martensite and austenite are subjected to strain.

In the work of M. P. Arbuzov and his co-workers [1-3], it was shown that the method of electrolytic dissolution could be used to isolate crystals of martensite, free from strains of the second kind.

The object of the present work was to define more precisely the conditions for the electrolytic separation of martensite from hardened steel, and also to carry out a series of experiments on the electrolytic separation of isolated austenite.

Separation of martensite by the method of anodic dissolution was carried out on samples of carbon steel of types U 10, U 12 and U 13 for different conditions of electrolysis and thermal treatment.

The best and most consistent results were obtained under the following conditions. The electrolyte was a N solution of potassium chloride with the addition of 0.5% of citric acid. The temperature of electrolysis was



a

b

c

Fig. 1. Structures of U 10 steel after quenching at different temperatures: a) 900°; b) 1100°; c) 1200°. × 1000.

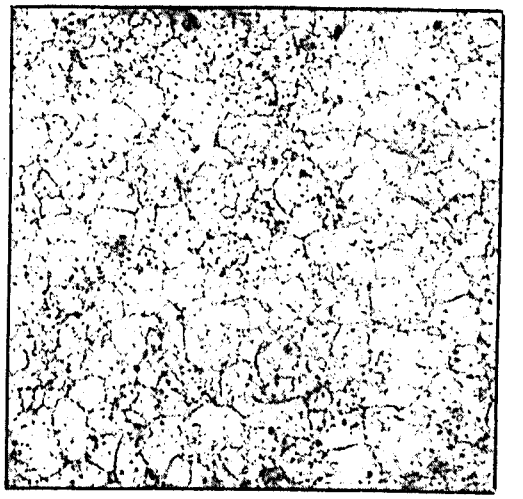


Fig. 2. Microstructure of Kh 12 M steel, quenched at 1150°. × 200.

Fig. 3. Particles of austenite powder, separated electrolytically from Kh 12 M steel. × 200.

+ 3° (raising the temperature to + 10° led to staining of the separated martensitic phase); the current density was 0.01-0.02 amp/cm². The duration of anodic dissolution was reduced to 2 hours (instead of 6-8 hours) [4].

The samples were quenched in 10% sodium hydroxide solution at temperatures of 900, 1100 and 1200°.

To avoid self-annealing during the process of quenching, the samples used were of small diameter and were quenched in 10% sodium hydroxide solution. As a preliminary control of the suitability of the structure for the separation of martensite powder, polished sections were etched with 4% nitric acid. Rapid etching (of the order of a few seconds) corresponded to a structure of annealed martensite, which did not segregate in the electrolytic residue, while slow etching

(of the order of a few minutes) corresponded to an unannealed martensite structure.

Figure 1, a,b and c, shows the microstructures of steel U 10 after quenching at different temperatures. In all three cases the electrolytic residue gave the same x-ray diffraction pattern of the isolated martensite . With a quenching temperature of 1200° (Fig. 1, c), the powder showed coarse crystals of martensite, as revealed by the existence of dark feet to the continuous curves of the diffraction photos.

It should be noted that the martensite powder was not separated with a coarse crystalline structure from quenched steel when the martensite and austenite were sharply differentiated. Thus there was no separation of martensitic powder from steels containing 1.4% C and 1% Mn, with either annealed or unannealed structures.

Thus the quenching temperature of the sample did not affect the separation of martensite in the anodic dissolution process. The rate of cooling from the quenching temperature must have ensured the formation of martensite in the quenching; after annealing, martensite did not separate at the anode on electrolysis. The quantity of martensite was not important, but its presence was necessary for the separation of martensite powder at the anode.

Austenite powder was obtained by electrolytic dissolution of steels of types Kh 12 M, Kh 12 F and E I 69, whose structures contained excess of carbide as well as austenite.

The electrolyte used for the separation of austenite was a 1% solution of hydrochloric acid. The current density was 0.01-0.02 amp/cm^2, and electrolysis was continued for 4 hours. It was necessary to warm the electrolyte to 30-50°. A reduction of the electrolyte temperature led to a reduction in the austenite content of the residue which separated, and if the electrolysis was carried out below + 5° there were austenite crystals in the residue.

The samples were quenched at 1100-1200°. From a comparison of Fig. 2 and 3, it is obvious that the dimensions of the grains of austenite powder, separated from steel Kh 12 M, correspond with those of the austenite grains shown metallographically. This establishes that electrolysis isolated individual grains of austenite, and the powder obtained was monocrystalline.

Austenitic powder was not obtained by electrolysis from steels with a purely austenitic structure (type 1 Kh 18 H 9 T), where the carbide phase was absent.

Thus, one of the conditions, necessary for producing isolated austenite by anodic dissolution, is the presence of a carbide phase. In addition, the grain boundaries must be clearly visible in the microstructure after etching.

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MICROSTRUCTURAL INVESTIGATION OF PHASE TRANSFORMATIONS IN METALLOCERAMIC SYSTEMS ON HEATING

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The phase transformations and volume changes induced by thermal treatment determine, to a considerable extent, the working properties of a number of products. With copper-tin and copper-tin-lead alloys, heating