

ELECTROPOLISHING AND ELECTROETCHING OF METALLOGRAPHIC SECTIONS OF METALLOCERAMIC MATERIALS WITH AN IRON-COPPER BASIS

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For the electrolytic polishing of sections of two-phase and single-phase metalloceramic materials, we used a special apparatus, the principle of which is shown in Fig. 1.

The sample holder, 1, of stainless steel, which supplies the current to the section, is fixed to the brass rod, 2. The collar, 3, and setscrew permit adjustment of the distance between the anode (the section) and the stainless steel cathode, 4, which is supported by the brass rod, 5. The current to the anode and from the cathode is conducted through the brass plates, 6 and 7. To prevent cathodic polarization, the cathode has an area 10 times greater than that of the section anode.

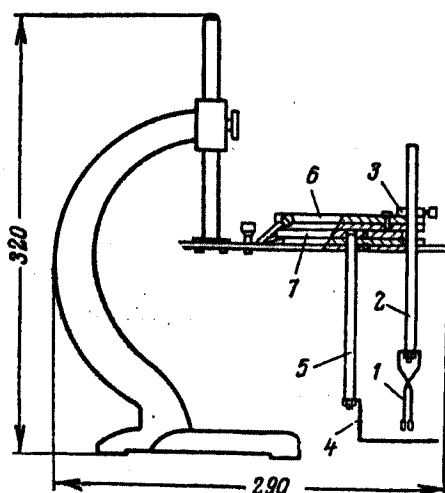


Fig. 1. Diagram of apparatus for electropolishing of metallographic sections of metalloceramic materials.

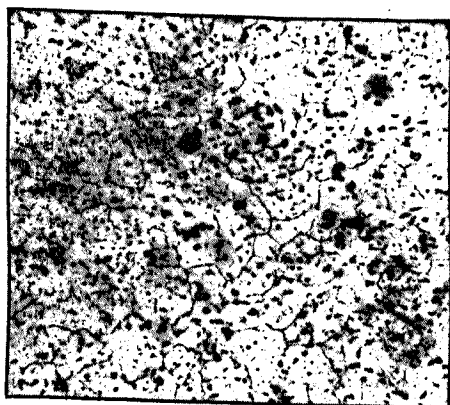


Fig. 2. Microstructure of a porous iron sample.

A phosphoric chromic acid electrolyte, consisting of 88% orthophosphoric acid and 12% chromic acid (by weight), was used for electropolishing.

The chromic anhydride was dissolved in concentrated orthophosphoric acid heated to 60-80°. It should be noted that the presence of even a small quantity of water leads to considerable oxidation of the sample.

The preparation of the section and the electropolishing were carried out in the usual way. The surface of the section, prepared on a stone, was treated successively with emery papers KZ320, KZ280, KZM20 and KZM14, and then polished on a cloth moistened with a suspension of aluminium oxide in water.

Before commencing electropolishing, the side surface of the sample was wiped with polishing paper and washed with alcohol, to remove contaminants and oxides (with the object of securing a good electric contact).

The electropolishing of nonporous metalloceramic materials was carried out at a temperature of 50-70° and a current density of 1.25 amp/cm²; the polishing time was 2 minutes, and the distance between the section (anode) and cathode 3-5 mm.

Non porous iron-copper metalloceramic materials were obtained by impregnation, and porous metalloceramics with an iron or iron-copper basis were prepared by sintering and compression.

Complete removal of scratches was not necessary for the electropolishing of the nonporous metalloceramics.

Complete preliminary removal of scratches was essential with porous materials, and it was therefore possible to reduce the time of electropolishing to 1 minute. In this case the current density was increased to 1.51 amp/cm².

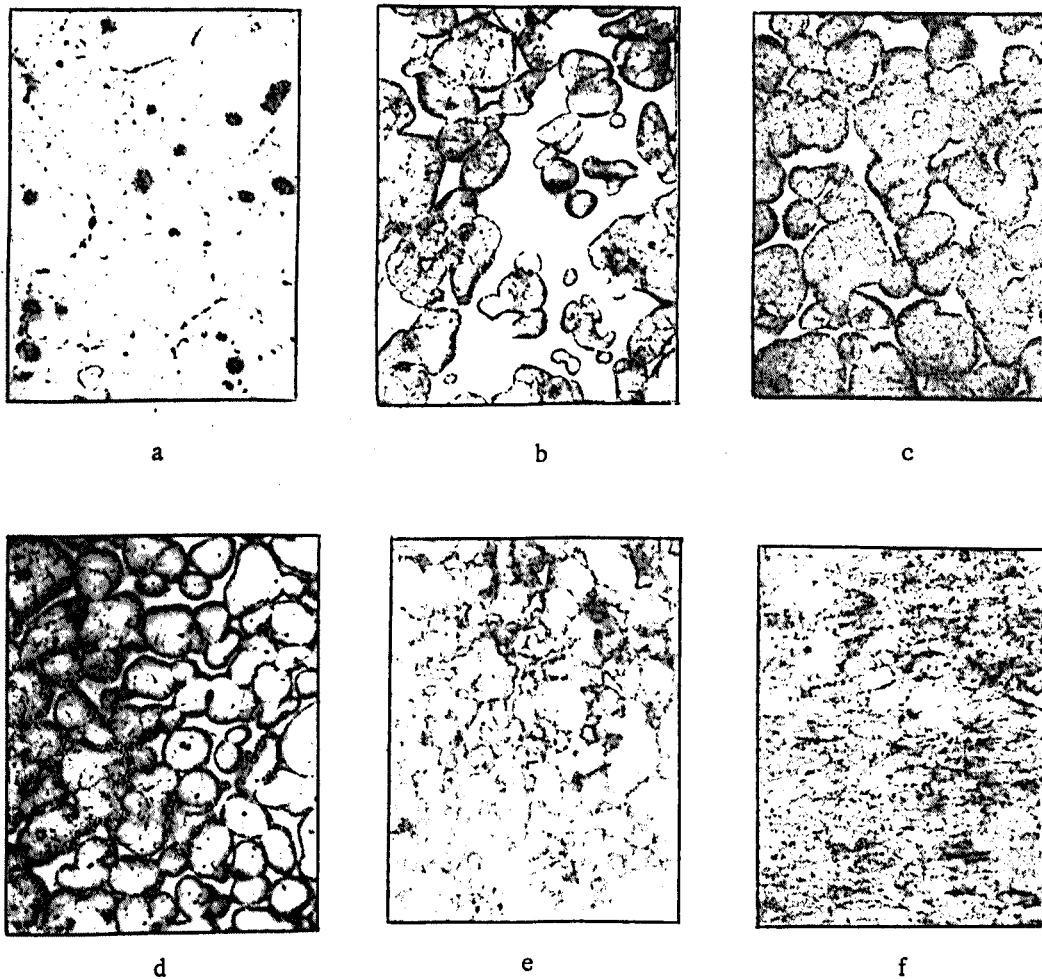


Fig. 3. Microstructures of iron-copper compositions after quenching with water at 1000° and annealing at 430° for 3 hours. $\times 320$. The copper contents of a to f are, respectively, 98, 50, 37, 30, 20 and 12%.

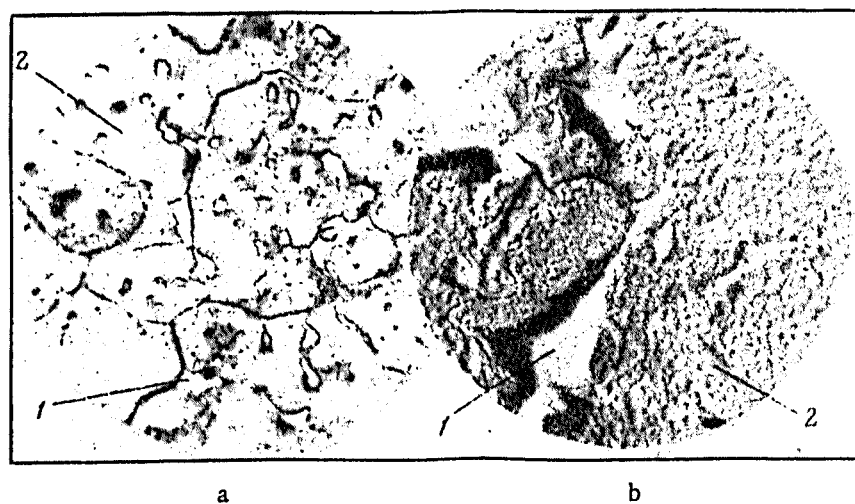


Fig. 4. Microstructure of the section of an iron-copper, metalloceramic, nonporous alloy.

Reduction of the current density to 0.05 amp/cm² 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