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INFLUENCE OF HYDROGEN ION CONCENTRATION ON THE CRYSTAL STRUCTURE OF ELECTRODEPOSITED COBALT

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Abstract

Cobalt crystallizes in the cubic and hexagonal systems. This paper shows by means of x-ray diffraction analysis, that cobalt electrodeposited from high pH (alkaline) sulphate solutions has a hexagonal structure which changes into a mixture of hexagonal and cubic, as the pH is decreased.

H ULL¹ has shown that cobalt has hexagonal close-packed as well as face centered cubic lattices, and that both types of lattice are obtained by rapid electrolysis of the sulphate. The purpose of this investigation was to determine whether the hydrogen ion concentration of the electrolyte influences the structure of the electrodeposited cobalt.



Fig. 1. Schematic diagram of the camera.

Experimental

Cobalt was deposited from an electrolyte having the following composition:² Cobalt sulphate (CoSO₄:7H₂O), 504 gm/liter; sodium chloride (NaCl), 17 gm/liter; boric acid (H₃BO₃), 45 gm/liter, at 30°C and 1 amp/dm² with cast cobalt anodes (98–99 percent pure) and stainless steel cathodes. The hydrogen ion concentration was adjusted with H₂SO₄ and NH₄OH and measured with a quinhydrone electrode.

The x-rays were supplied by a chromium target gas-type tube³ operated

¹ Hull, Phys. Rev. 17, 571 (1921).

² Blum and Hogaboom, Principles of Electroplating and Electroforming, 2nd ed., p. 280, 1930.

³ Kersten, Rev. Sci. Inst. 3, 145 (1932).

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at 20 kv and 40 m. a. The camera is illustrated schematically in Fig. 1. The diameter of the ring around which the film was wrapped was such that 0.025 inch on the film corresponded to 1° . The black line at the right end of each photograph in Fig. 2 was made by the main beam before the sample was put in place.

Theoretical

The positions of the diffracted images of the main x-ray beam, plotted from the data given by Hull,¹ are shown for both lattice types in the lower part of Fig. 2. All the theoretically possible lines do not appear in the photographs but it is evident that the 200 $K\alpha$ line, indicated by an arrow, is the best



Fig. 2. Influence of pH on the crystal structure of electrodeposited cobalt.

one to use as a test for the presence of cubic cobalt since it is one of the strongest lines appearing in the photographs when a large percentage of cubic crystals are present in the cobalt.

Results

Fig. 2 indicates that hexagonal cobalt is deposited at high values of pH from the electrolyte used and that the structure gradually changes into a mixture of hexagonal and cubic as the pH is decreased.