Characterization of Electrodeposited Ni-Co Alloy Powders

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Almost all materials can be made into powder, but the method selected for production of powder depends on the specific material properties. The electrolytic powder production method usually yields products of high purity, which can be well pressed and sintered [1]. Only a few papers concerning Ni-Co powder electrodeposition exist in the literature [2-4].

The morphology, phase and chemical composition of Ni-Co alloy powders electrodeposited from ammonium sulfate-boric acid containing electrolyte with different ratio of Ni^{2+}/Co^{2+} ions were investigated. Ni-Co powders were electrodeposited at a constant current density of approximately 70 $mAcm^{-2}$ from electrolytes containing 0.4M H_3BO_3, 0.2M Na_2SO_4 and Ni and Co sulfate salts. The ratios of Ni^{2+}/Co^{2+} ions were 1.00, 0.50 and 0.33.

The morphology, phase and chemical composition of these powders were investigated using SEM, XRD, EDS and AAS analysis.

The morphology of the Ni-Co alloy powders is sensitive to the Ni^{2+}/Co^{2+} ions ratio in the electrolyte. At the highest investigated ratio typical 2D fern-like dendritic particles were obtained (Fig. 1a). With the decrease of Ni^{2+}/Co^{2+} ions ratio (0.5) among 2D fern-like dendrites, compact agglomerates were detected (Fig. 1b). At the lowest Ni^{2+}/Co^{2+} ions ratio of 0.33 the appearance of densely packed 3D dendritic particles (Fig. 1c) has been detected.

The X-ray diffraction patterns of three samples are shown in Fig. 2a. As can be seen XRD patterns contain the characteristic peaks of Ni reach phase (△) with fcc lattice, hcp Co phase (♦) and fcc Co phase (▼). With the decrease of Ni^{2+}/Co^{2+} ions ratio, peaks of Ni rich phase (△) become smaller and some of them disappear, while the peaks of hcp Co phase (♦) become visible. It is interesting that non-equilibrium fcc Co phase has been detected in the Ni-Co alloy powders electrodeposited from electrolyte with the lowest Ni^{2+}/Co^{2+} ions ratio.

According to the results of the chemical analysis of electrodeposited powders, the ratio of Ni^{2+}/Co^{2+} ions, i.e. electrolyte composition, significantly influenced the composition of electrodeposited powders. It should be noted that both elements, Ni and Co were analyzed independently and that for all samples their sum was not 100%, but about 90%. The results of the EDS analysis indicate that the third element was oxygen.

The influence of the electrolyte composition on the alloy powder composition is shown in Fig. 2b. According to Brenner's classification [5], such behavior indicates anomalous type of powder co-deposition. The characteristic of anomalous co-deposition is that it occurs only under certain condition of concentration and operating variables for a given plating bath. [2,4,5].

From the presented results it can be concluded that the composition of the electrolyte, i.e. the ratio of Ni^{2+}/Co^{2+} ions concentration, influences morphology, phase and chemical composition of the Ni-Co alloy powders.

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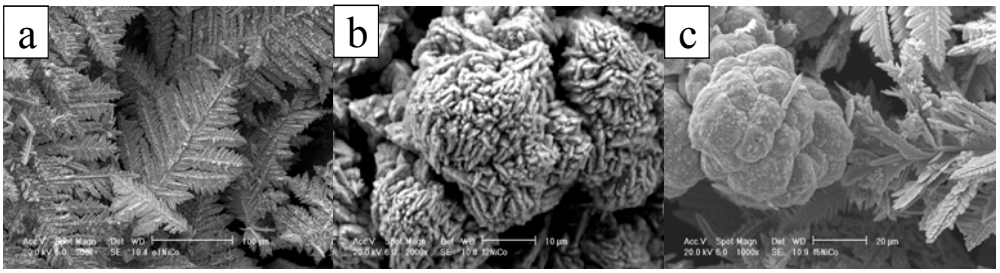

Figure 1. Morphology of Ni-Co powders electrodeposited from electrolytes containing: (a) Ni^{2+}/Co^{2+} = 1.00; (b) Ni^{2+}/Co^{2+} = 0.50; (c) Ni^{2+}/Co^{2+} = 0.33.

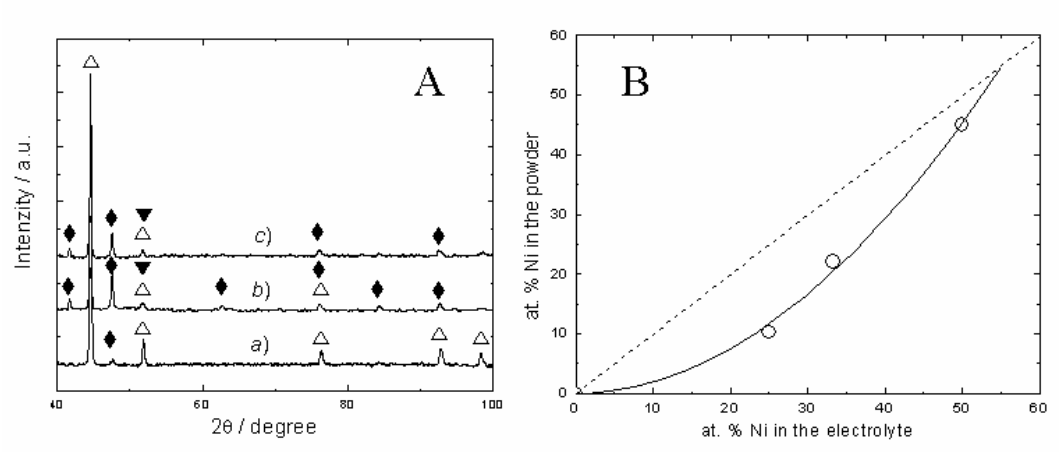

Figure 2. A-X-ray diffractograms of Ni-Co powders electrodeposited from electrolytes containing: (a) Ni^{2+}/Co^{2+} = 1.00; (b) Ni^{2+}/Co^{2+} = 0.50; (c) Ni^{2+}/Co^{2+} = 0.33; B-Atomic percentage of Ni in the alloy powder as a function of the atomic percentage of Ni in the electrolyte.

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