The Application of NiCo Alloy Electroforming on Products with microstructure

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Abstract

This assay demonstrates a manufacturing method of a metal net with microstructures. The method produced a metallic net mold by duplicating the original photo-resistor-made mold. This new metallic net mold has higher precision and longer life-time than present products. The electrolyte contents in the study include 300g/L nickel aminosulfonate, 20g/L cobalt aminosulfonate, 30g/L biric acid, 10g/L nickel chloride, 0.5g/L naphthalenedisulfonic acid sodium salt, and surfactants. The properties of NiCo alloy are: hardness 45~50 HRC, grain size <200nm, average roughness <40nm, and element ratio Ni/Co = 70%/30%.

Introduction

The technologies of electroforming have been widely applied to industrial products. The most attractive point of the electroforming technique is the capability of 100% topographic duplication. This feature is especially important for commercial products such as stampers for compact discs, master molds for holograms, and master molds for non-spherical mirrors. In recent years, many scientists and company researchers work to improve the surface characteristic of electroformed layers because of more demand for high quality for industrial electroforming.

The major challenge to industrial applications is higher productivity with good quality for end products. According to this requirement, raising higher limiting current density is the main issue. Adding a pulsed current is the dominating course of the recent researches. The application of an external magnetic field is another possible idea to overcome the technological bottleneck of current density. However, the resulting Lorentz force, additional paramagnetic force, and magnetic gradient force have negative influences on the morphology and roughness of electroformed layers. The bad effects should be turned to positive effects.

The mechanism of chemical reactions in the electrolyte and ion collisions in the deep holes of mold is not well-known at present. In other words, there is no theoretical model to support the quantitatively relations among the magnitude of electric and magnetic fields, and forming rate. Experiment data would be very valuable for high aspect ratio electroforming process.

Experimental

1) Apparatus: The experiment apparatus was shown in figure 1. The system includes a process tank, a power supply, a filter device, a temperature controller, a water supply, and an air exhausting device.

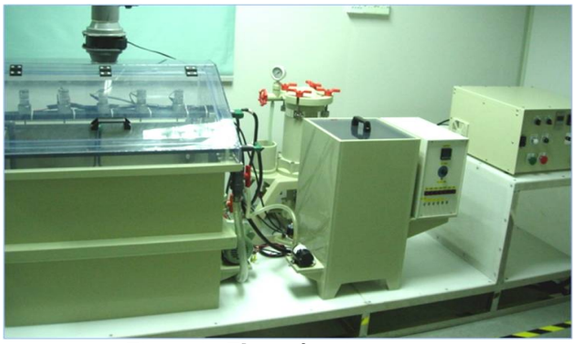

Figure 1. Electroforming system

2) Electrolyte: The electrolyte contains 300g/L nickel aminosulfonate, 20g/L cobalt aminosulfonate, 30g/L biric acid, 10g/L nickel chloride, 0.5g/L naphthalenedisulfonic acid sodium salt, and surfactants. The operating temperature is 45℃, and current density is 1 A/dm2.

Results and Discussion

1) AFM morphology: The AFM morphology of Ni-Co alloy was shown in figure 2. The structure of Ni-Co alloy was smooth. Its average roughness and grain size are less than 40nm and 200nm, respectively.

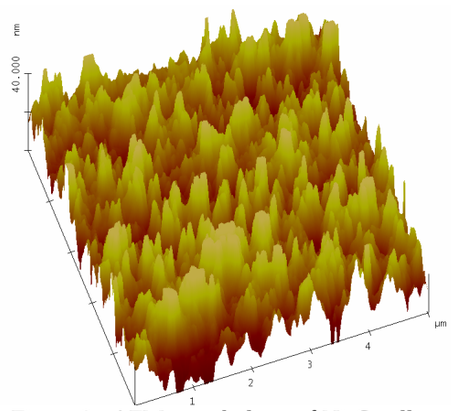

Figure 2. AFM morphology of Ni-Co alloy

2) EDS analysis: The results of EDS analysis on Ni-Co alloy showed that the ratio of Ni/Co was 70%/30%. Furthermore, the hardness of Ni-Co alloy was between 45 to 50 HRC.

3) SEM morphology: The SEM morphology of Ni-Co alloy for micro-fabrication was shown in figure 3. It is apart of net structure and its shape is more precise than that of present products.

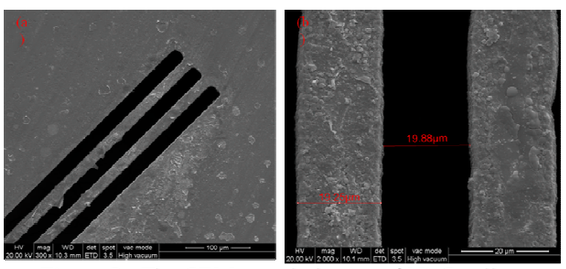

Figure 3. The SEM morphologies of Ni-Co alloy