High Strength Electrodeposited Ni-B alloys and Their Thermal Stability

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Nickel electrodeposits have been widely applied in miniaturized electronic devices due to excellent magnetic and mechanical properties, but they typically exhibit low thermal stability [1]. They start recrystallizing rapidly and lose their mechanical properties at relatively low temperatures. Poor thermal stability is a major limitation when applying nanocrystalline Ni to MEMS devices. It has been reported that the incorporation of boron significantly enhances the mechanical strength, corrosion resistance and thermal characteristic of Nickel [2].

Electrodeposition method is widely used in Ni-B alloy deposition. Comparing with the electroless plating, electrodeposition method offers several advantages, such as high deposition rate, uniform distribution of B in the deposit and ease control of the process. In addition, the average grain size and composition can be easily controlled by the electrodeposition condition, such as the current density.

Ni-B alloys were prepared by electrodeposition with a Watt's bath. The B content varied from 2.8 to 14.3 at.% as the current density decreased from 4 to 1 A/dm^2. Crystalline structure of the Ni-B alloys was characterized by X-ray diffraction (XRD). Thermal stability test of Ni-B alloys were conducted to evaluate their mechanical performance after heat treatment at 250 °C. The mechanical property in micro-scale were evaluated by micro-compression test using micro-pillar type specimens fabricated by focused ion beam system. B content in the Ni-B alloy deposits reduced and micro-hardness increased as the current density increased as shown in Fig. 1. The compressive strength of the Ni-B alloy having the cobalt content of 3 at.% reached a maximum of 5.67 GPa after 4 h heat treatment.

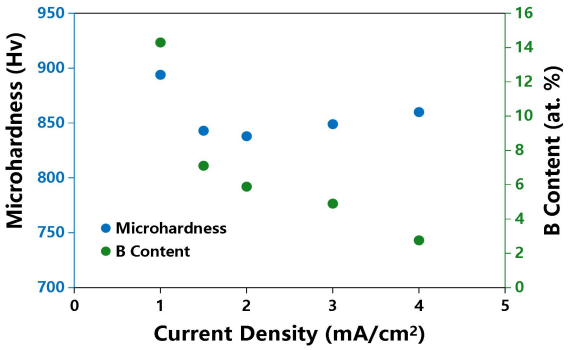

Figure 1. Effects of the current density on the micro-hardness and B content.

References

[1] R. A. Andrievski, J. Mater. Sci. **38** (2003) 1367-1375.

[2] Yu. N. Bekish, S. K. Poznyak, L. S. Tsybulskaya, T. V. Gaevskaya, Electrochim. Acta, 55 (2010) 2223-2231.