Amorphous Ni-P Alloy Deposition by Electroforming Technology

Tai-Chang Chen[1], Hsi-Jhu Chen[1], Chang-Ying Hsieh[2],

[1]Metal Industries Research & Development Centre
[2]Department of Chemical Engineering, National Cheng-Kung University

[1]No.1001, Gaonan Highway, Kaohsiung City 811, Taiwan
[2]No.1, University Road, Tainan City 701, Taiwan

Introduction

Nickel-Phosphorous alloy is a kind of amorphous material which is non-crystal and only single phase. In other words, crystal defects such as lattice dislocation, crystal interface does not exist in this kind of material. By the above property, the corrosion between crystal interfaces would not occur on Ni-P alloy. It means that the anti-corrosion capability of Ni-P alloy is better than that of non-amorphous alloys. By controlling phosphorous content in alloy with 8~10%, the Ni-P material becomes amorphous phase, and its hardness is about 500~550Hv. (It can achieve 800Hv after heat treatment.) With the above characteristics, this alloy has lots of applications in industries. [1~5]

Experimental conditions

1) Electrolyte:

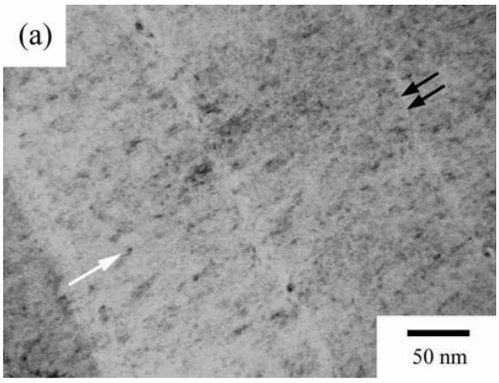
Component	Contents
Nickel sulfamate	50, 90, 120 g/L
Boric acid	40 g/L
Nickel chloride	3 g/L
Phosphorous acid	0~40 g/L
surfactant	1.8 g/L

2) Operating parameters:

Parameter	Value
Current density	8 A/dm^2
Temperature	50 ℃
Duty cycle	50%, 10%

Results and Discussion

1) Effect of DC and pulse power: Pulse current function is controlled by duty cycle. In this assay, the major study was to investigate the effect of various types of electron current on the structure of deposit layers. Figure 1 showed the SEM graphs of the surface of Ni-P deposit layers. In figure 1(a), the alloy layer deposited by DC current was layered texture which was not an amorphous structure. In figure 1(b), the alloy layer deposited by pulse current was a uniform and smooth layer which was amorphous.



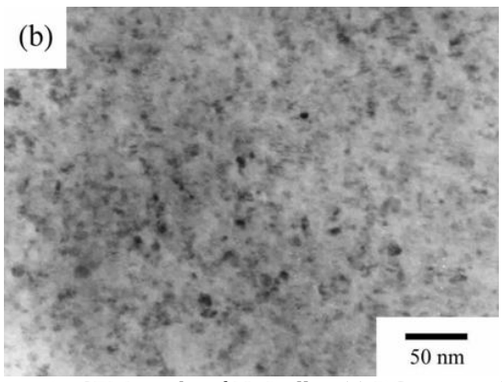


Figure 1. SEM graphs of Ni-P alloy (a) DC current, (b) pulse current

2) Effect of phosphorous amount of Ni-P alloy at different Ni2+ concentrations: The phosphorous in the electrolyte provide the phosphorus source of Ni-P alloy directly. However, the concentration of nickel ion also affects the deposit ratio of phosphorus to the alloy. Figure 2 showed their relationships.

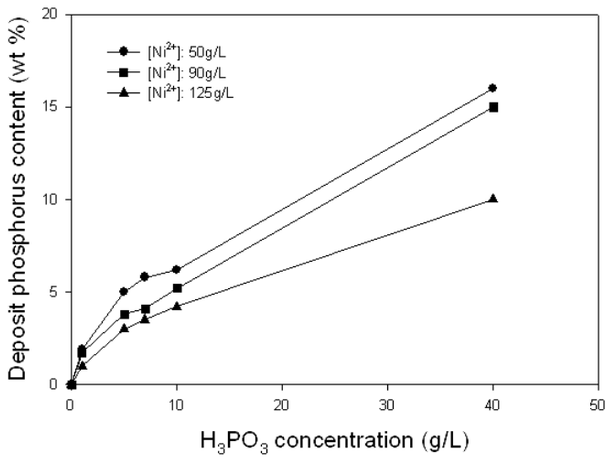


Figure 2. Effect of phosphorous amount of Ni-P alloy at different Ni2+ concentrations

References

[1] M. G. Fontana, Corrosion Engineering, 3, B and Jo Enterprise, Singapore, 1986, p.243
[2] J. E. Williams, C. Davison, J. Electrochem. Soc. 137 (1990) p.3260
[3] D. Osmola, P. Nolan, U. Erb, G. Palumbo, K. T. Aust, Phys. Stat. Sol. (a) 131 (1992) p.569
[4] A. Robertson, U. Erb, G. Palumbo, Nanostruct. Mater. 12 (1999) p.1035
[5] M. H. Seo, J. S. Kim, W. S. Hwang, D. J. Kim, S. S. Hwang, B. S. Chun, Surface and Coatings Tech. 176 (2004) p.135