Electrodeposition and characterization of Ni-W-Si_3N_4 alloy composite coatings

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초 록: Ni-W-Si_3N_4 alloy composite coatings were prepared by pulse electro-deposition method using nickel sulfate bath with different contents of tungsten source, $Na_2WO_4.2H_2O$, and dispersed Si_3N_4 nano-particles. The structure and micro-structure of coatings was separately analyzed by X-ray diffraction (XRD) and scanning electron microscope (SEM). Results indicated that nano Si_3N_4 and W content in alloy had remarkable effect on micro-structure, micro-hardness and scratch resistant properties. Tungsten content in Ni-W and Ni-W-Si_3N_4 alloy ranged from 7 to 14 at.%. Scratch test results suggest that as compared to Ni-W only, Ni-W-Si_3N_4 prepared from Ni/W molar ratio of 1:1.5 dispersed with 20 g/L Si_3N_4 has shown the best result among different samples.

1. 서론

Ni-W alloy was developed as one of the surface treatments to replace hard chromium coating for its excellent properties. Tungsten (W) being noble to chemical attack and can provide the most beneficial effects on mechanical and tribological properties, is one of the potential metal for providing protective coatings by alloying together with Nickel coatings. Nevertheless, recent trends on composite electro-deposition is basically focused with alloy system together by inserting ceramic nano-particles. Therefore, in this study, we have evaluated mechanical and scratch resistance properties of electro-deposited Ni-W-Si_3N_4composite coatings.

2. 본론

XRD patterns revealed the typical diffraction patterns of FCC Ni-W alloy. Incorporation of Si_3N_4 ceramic nano-particles did not affect the structural properties of the alloy composite coatings as shown in Fig. 1. Vickers micro-hardness of Ni-W-Si_3N_4 alloy composites are found to be increased as compared to Ni-W alloy only and reached to ~ 960 HV.

Table 1. Processing parameters

Chemicals	Bath 1 (B1)	Bath 2 (B2)	Bath 3 (B3)	purpose
$NiSO_4.6H_2O$	0.075 M	0.075 M	0.075 M	Ni Source
$Na_2WO_4.2H_2O$	0.075 M	0.112 M	0.15 M	W Source
$Na_3C_6H_5O_7.H_2O$	0.15 M	0.187 M	0.225 M	Complexing agent
NH_4Cl	0.5 M	0.5	0.5 M	Buffer

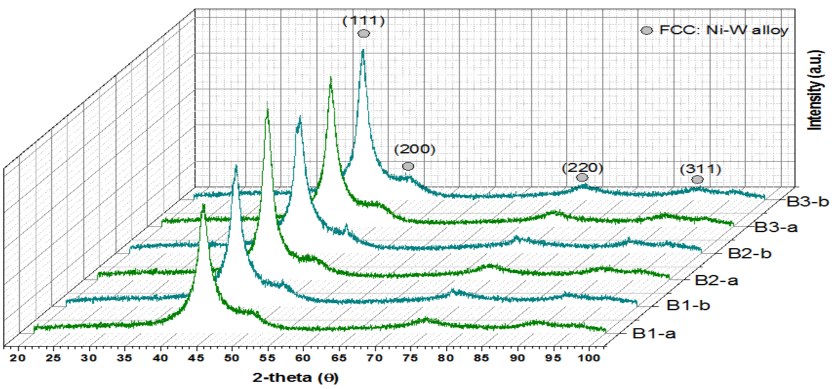

Fig. 1. XRD patterns of Ni-W and Ni-W-Si_3N_4 alloy composite coatings

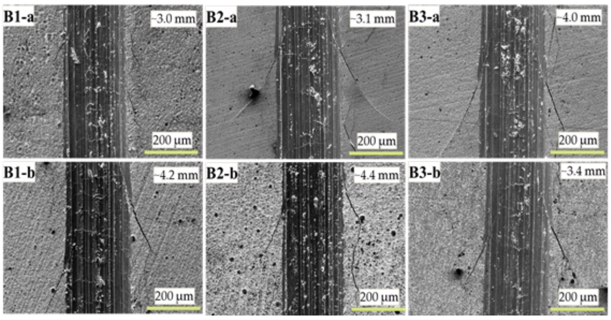

Fig. 2. SEM micrographs of worn surfaces of Ni-W and Ni-W-Si3N4 composite alloy coating during scratch test

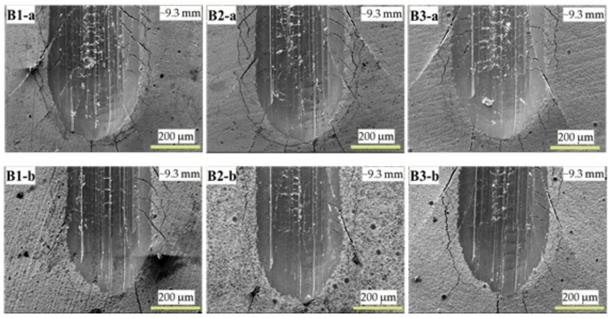

Fig. 3. SEM micrographs of worn surfaces at the end part of scratch length.

3. 결론

- Ni-W alloy with 7 to 14 at.% of W was successfully prepared.
- Si_3N_4 nano-particles were co-deposited in Ni-W alloy.
- Increased vickers micro-hardness of Ni-W-Si_3N_4 alloy composites were observed as compared to Ni-W alloys.
- Scratch test was performed with progressive load from 30 N to 120 N. Depending upon sudden change in coefficient of friction and acoustic emission, critical load was evaluated.
- Ni-W-Si_3N_4 prepared from Ni/W molar ratio of 1:1.5 (sample B2-b) showed highest scratch critical load around 73 N. On the other hand, poor scratch resistance was observed on sample B1-a which showed critical load around 57 N.

참고문헌

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