Electrodeposited Ni-W-Si_3N_4 alloy composite coatings: Evaluation of Scratch test

Gobinda Gyawali, Bhupendra Joshi, Khagendra Tripathi, and Soo Wohn Lee[a]

Research Center for Eco Multi-Functional Nano Materials, Sun Moon University, Korea

(E-mail:swlee@sunmoon.ac.kr)

초 록:

In this study, Ni-W-Si_3N_4 alloy composite coatings were prepared by pulse electrodeposition 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 microstructure ofcoatings 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 microstructure, microhardness 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 electrodeposition is basically focused with alloy system together by inserting ceramic nanoparticles. Therefore, in this study, we have evaluated mechanical and scratch resistance properties of electrodeposited 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 nanoparticles did not affect the structural properties of the alloy composite coatings as shown in Fig. 1. Vickers microhardness 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

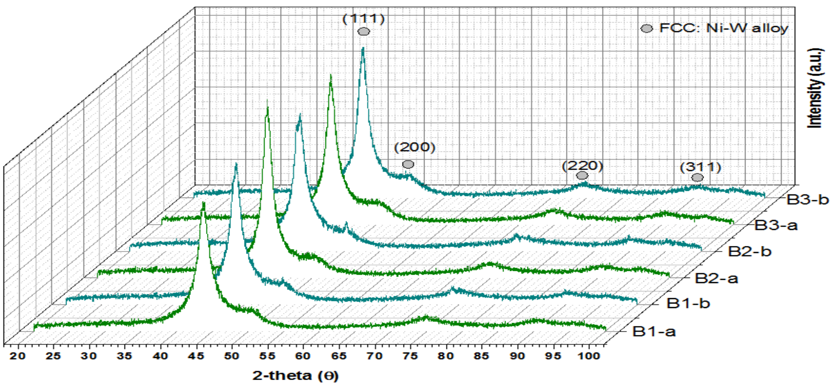

Fig. 1. XRD patterns of Ni-W and Ni-W-Si_3N_4 alloy composite coatings

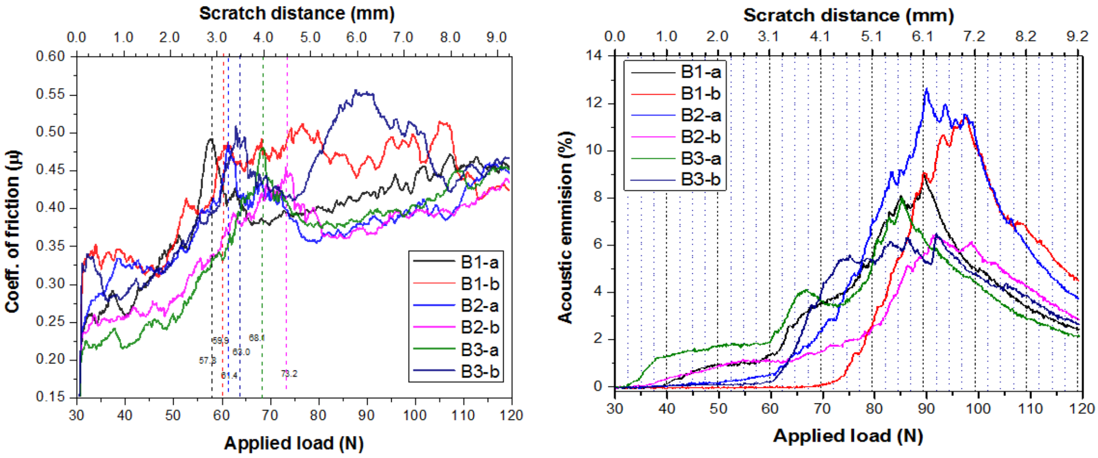

Fig. 2 Variation of coefficient of friction (left side) and evolution of AE (right side) of Ni-W and Ni-W-Si_3N_4 composite Alloy coatings during scratch test. (Conditions: Load 30 to 120 N, loading rate 197.23N/min, length 9.3 mm, diamond tip radius 200 μm)

3. 결론

- Ni-W alloy with 7 to 14 at.% of W was successfully prepared.
- Si_3N_4 nanoparticles were codeposited in Ni-W alloy.
- Increased vickers microhardness 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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