

Electrode Performance of Newly Developed Ni-W-S Deposited Alloy for Alkaline Water Electrolysis

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Ni-W-S coatings were fabricated by electroplating in each bath as shown in Table 1. The electroplating was treated on SUS430 stainless steel (Japanese Industrial Standard) substrate (10 mm x 5 mm x 0.5 mm), that has a smooth surface and does not contain nickel, was selected as a base material. As pretreatment for electroplating, the substrate was degreased by acetone and etched by Ferric chloride. Nickel plate having an enough surface area was employed as an anode for electroplating.

The bath denoted as “Ni-W-S No.1” was derived from a neutral pH bath for Ni-W alloy plating.[1] Furthermore, sulfosalicylic acid was added as a stress reducer in order to prevent surface cracks. In the solution denoted as “Ni-W-S No.2” contains sodium tungstate, as a source of tungsten, sodium citrate and ferric chloride. Plating solution denoted as “Ni-S” is same bath with Ni-W-S No.2 without sodium tungstate.

Ni-W-S electrodes showed significantly excellent characteristics as a cathode for alkaline water electrolysis. Specifically, the Ni-W-S electrode in which sulfosalicylic acid was added as a stress reducer exhibited an excellent performance comparing to conventional Ni-S and Ni cathode. (Ni-W-S No.1 in figure 1)

In order to obtain the performances of thus obtained electrode for alkaline water electrolysis, an electrode surface morphology was observed by SEM and the film composition was evaluated by EDX. In order to specify the crystal structure, XRD was employed. Furthermore, in order to evaluate the durability performance as a cathode for water electrolysis, sequential changes in electrode performance was investigated periodically using LSV while performing long-term electrolysis test for 48 hours as shown in figure 2 and summarized in table 2. Furthermore the prevention of sulfur dissolution during cathodic polarization was monitored.

References

[1]The Surface Finishing Society of Japan: Handbook of Surface Finishing, p. 212 (THE NIKKAN KOGYO SHIMBUN,Co. LTD., 1988)

Table 1 Bath composition and plating condition

Ni-W-S No.1		g/L	Stress reducer	
NiSO <sub>4</sub>		40		
C <sub>6</sub> H <sub>4</sub> (OH)(SO <sub>3</sub> H)COOH·2H <sub>2</sub> O		4		
Na <sub>2</sub> WO <sub>4</sub>		70		
CH <sub>3</sub> N <sub>3</sub> S		76		
C <sub>6</sub> H <sub>5</sub> O <sub>7</sub>		80		

Ni-W-S No.2		g/L
NiSO <sub>4</sub>		29
Na <sub>2</sub> WO <sub>4</sub>		73
CH <sub>3</sub> N <sub>3</sub> S		76
C <sub>6</sub> H <sub>5</sub> Na <sub>3</sub> O <sub>7</sub> ·2H <sub>2</sub> O		62

Ni-S		g/L
NiSO <sub>4</sub>		29
CH <sub>3</sub> N <sub>3</sub> S		76
C <sub>6</sub> H <sub>5</sub> Na <sub>3</sub> O <sub>7</sub> ·2H <sub>2</sub> O		62

Ni-W-S No.1	
Anode	Ni
Current Density(A/dm <sup>2</sup> )	120
Bath Temp.(°C)	60
pH	4
Thickness (μm)	4~5

Ni-W-S No.2, Ni-S	
Anode	Ni
Current Density(A/dm <sup>2</sup> )	120
Bath Temp.(°C)	60
pH	9
Thickness (μm)	4~5

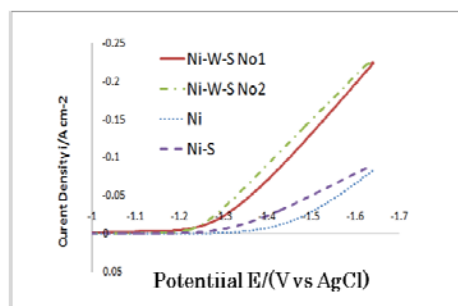


Fig. 1 Cathodic polarization curves of Ni, Ni-S, Ni-W-S No.1, and Ni-W-S No.2 at the scan rate of 10 mV/sec in 30 wt% KOH aq. solution.

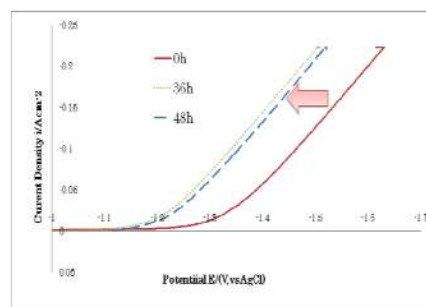


Fig. 2 The series change of cathodic curve for Ni-W-S No.1 during long-term electrolysis at a scan rate of 10 mV/sec in 30 wt% KOH solution.

Table 2 The series change of log i<sub>0</sub> (A/cm<sup>2</sup>) and hydrogen overvoltage of Ni, Ni-S, Ni-W-S No.1 and Ni-W-S No.2.

	Before electrolysis	After 48h electrolysis	Before electrolysis	After 48h electrolysis
	Log i <sub>0</sub> (A/cm <sup>2</sup> )		Hydrogen overvoltage (V)	
Ni	-4.50	-	0.43	-
Ni-S	-2.92	-	0.34	-
Ni-W-S No. 1	-1.87	-1.28	0.32	0.29
Ni-W-S No. 2	-1.92	-1.97	0.31	0.31