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Effect of Nucleosides on the Ni electrodeposition in Formamide and DMSO bath : A Comparative study

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Abstract: Presence of nucleoside (Ribocytidine and Deoxy Cytidine) during electrodeposition of Ni in non-aqueous bath results in more outwardly growth than lateral growth. The outwardly growth of the electrodeposit is facilitated by slow release of cation from the metal non aqueous complex. Too many coordinating centers of nucleosides facilitates the slow release of Ni3+ from [Ni (DMSO)6]3+/ [Ni(HCONH2)6]3+ complex in the vicinity of catholite causing outwardly growth more dominant than lateral growth, resulting in bright, adherent, Ni electrodeposite.

Slow release of Ni3+ from Ni-Formamide bath appears to be more proper than Ni-DMSO bath.

Key Words: Nickel electrodeposits, nucleosides, formamide, catholite,outwardly growth, dominant .

Electrodeposition of Ni in non-aqueous bath is advantageous over aqueous bath because electrodeposition in aqueous media causes excess of hydrogen evolution along with the metal deposits. The inclusion and subsequent diffusion of hydrogen causes the electrodeposited metal structure weak with cracked topography. While non-aqueous bath results in bright and non cracked topography. Various non aqueous baths have been choosen and developed by various workers for Ni electrodeposition.1-4

Electrodeposition of metals in presence of organic additives have also been reported5-7. Additive free bath produce columnar grain structure while bath containing organic additives produce electrodeposite having equaxial grain. Various nucleosides have been used in non-aqueous baths (formamide8 and dimethyl sulphoxide9) to get good quality electrodeposit. In the present work an attempt was made to compare electrodeposition of Ni in DMSO and Formamide bath from nickel acetate in conjugation with nickel sulphate and nickel sulphamate in presence of trace amount of various nucleosides as additives.

Experimental Procedure- Solvent DMSO and Formamide were used as solvent. Copper strips 15x10x1 mm were used as cathode. These strips were first ground to produce a smooth surface, polished using various . grades of emery papers [1/0 to 4/0] and finally disc polished; they were cleaned, degreased in hot soap solution (idipol), electrolytically cleaned using sodium carbonate (pH 12.0) and finally solvent degreased using acetone; they were pickled in 10% sulphuric acid and after degreasing adequately, the specimen were cleaned in hot and cold double distilled water. High purity nickel sheets were used as anodes. A copper strip cathode was placed in between two anodes and interelectrode distance of 20 mm was maintained throughout the experiment . A copper coulometer was placed in series to measure the current . Thickness of the electrodeposited nickel was measured using ELECTROPHYSIK GERMAN Coating thickness gauge digital Minitest Model 600(B) and all the weights of the specimen before and after electrodeposition were taken on digital electronic balance (Swiss). Bath composition and operating condition are given in Table 1.

Results and Discussion

Effect of nucleosides- Effect of ribocytidine. The effect of ribocytidine (RC) in trace amount as an addition agent on the electrodeposition of the nickel from Dimethylsulphoxide(DMSO) and Formamide bath containing NiAc (0.2M), NiSO4 (0.2M)+NiSMT (0.2M) along with Boric acid (0.4M) as buffering agent was studied (Table 2 and 3).

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It was observed that addition of ribocytidine improved the quality of electrodeposit more in Formamide bath in comparison to DMSO bath. Addition of RC 0.005 M in formamide improves the reflectivity enormousouly as compared to DMSO but with poor efficiency . A good efficiency was observed in presence of 0.007M RC in Formamide bath but with inferior quality. On the other hand at higher conc. of nucleoside in DMSO bath results in black spot at the base of the electroplate.+

Effect of deoxycitidine- On changing the additive from ribocytidine to deoxycytidine in the above system, CCE% was better in Formamide bath than DMSO bath. In DMSO, some blak spots developed on plates so long the conc. Of DC was less but such spots vanished when conc. Of DC excesseded 0.01M. Maximum CCE% was obtained at 0.003 M DC in formamide bath while highest thickness was found at 0.01M DC in formamide bath.

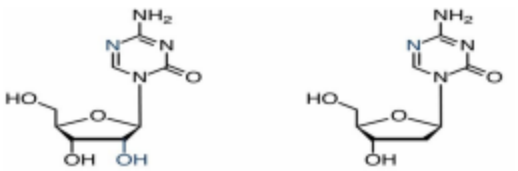

Table 1
Bath composition and condition of deposition

Parameters	Value
Nickel acetate*	0.2 M
Nickel sulphate**	0.2 M
Nickel sulphamate #	0.2 M
Boric acid	0.4 M
Ribo cytidine	0.005 – 0.05 M
Deoxy cytidine	0.005 – 0.05 M
Solvent	Dimethyl sulphoxide and Formamide
Temperature	45° C
Current density	0.5 Adm^2
Duration of electrolysis	60 min
Agitation	Nil

* $Ni(CH_3COO)_2.4H_2O$
** $NiSO_4.6H_2O$
# $Ni(SO_3NH_2)_2.4H_2O$

Table 2
Effect of Ribocytidine (RC) on electrodeposition of Nickel From DMSO bath

RC (M) (µm)	Nature of deposit	CCE (%)	Thickness
0.000	Garish, black spot With slight peeling	48.86	3.37
0.005	No peeling , Bright	24.76	3.52
0.007	No peeling, Hazy bright	62.1	4.30
0.009	Bright, no peeling	48.8	3.7
0.01	Bright, smooth, no peeling	58.58	3.52
0.02	Bright, smooth, no peeling	58.09	3.69
0.03	Bright, smooth, no peeling	58.29	3.55
0.04	Black spots. Peeling	58.51	3.10
0.05	Black spots. Less peeling	58.08	2.95

CCE : Cathode current efficiency
Bath composition: Nickel acetate (0.2 M), Nickel sulphate (0.2 M), Nickel sulphamate (0.2 M) boric acid (0.4 M) in DMSO
Additive : Ribocytidine (0.005M to 0.05M)
Operating condition : 0.5 Adm^2 and 45° C

Table 3
Effect of ribocytidine (RC) on electrodeposition of nickel From Formamide bath

RC (M)	Nature of deposit	CCE (%)	Thickness (µm)
0.000	Semi bright *	63.94	3.37
0.005	Bright	74.28	5.28
0.007	Bright	77.58	4.68
0.009	Bright	62.46	4.0
0.01	Bright, Smooth	68.99	5.16
0.02	Less Bright	56.65	4.61
0.03	Brightness reduces	62.36	4.60
0.04	Grnish Bright	60.75	4.38
0.05	Grnish Bright	70.55	4.86

C (%) cathode current efficiency
* Peeling
* Mild peeling
** Hydrogen evolution at cathode

Table 4
Effect of Deoxycytidine (DC) on electrodeposition of Nickel From DMSO bath

DC (M)	Nature of deposit	CCE (%)	Thickness (µm)
0.000	Garish, black spot Slight peeling	48.86	3.37
0.005	Black spots., Peeling	68.98	3.70
0.007	Dark bright, No peeling	60.50	4.00
0.009	Black spots on bright base No peeling	65.16	4.04
0.01	Smooth Bright	63.64	3.70
0.02	Smooth Bright, Light black at bottom	57.63	4.15
0.03	Mild peeling Dark black	61.09	4.19
0.04	Peeling black spots	58.95	4.00
0.05	Peeling dark black	68.08	4.30

Bath composition: Nickel acetate (0.2 M), Nickel sulphate (0.2 M), Nickel sulphamate (0.2 M) boric acid (0.4 M) in DMSO
Additive : Deoxycytidine (0.005M to 0.05M)
Operating condition : 0.5 Adm^2 and 45° C

Table 5
Effect of Deoxycytidine (DC) on electrodeposition of Nickel From Formamide bath

DC (M)	Nature of deposit	CCE (%)	Thickness (µm)
0.000	Semi bright, mild peeling	63.94	3.37
0.005	Bright, mild peeling	79.07	4.60
0.007	Bright, mild peeling	76.19	4.75
0.009	Bright, no peeling	67.85	4.49
0.01	Hazy bright, smooth	78.39	5.35
0.02	Bright	71.80	4.60
0.03	Bright, Smooth	80.24	4.00
0.04	Bright	61.95	4.08
0.05	Bright, Smooth	60.27	4.49

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