DisChem Analytical Services

Electroforming Solution Optimization

I. CUSTOMER INFORMATION:

REPORT NO. 104837

Company:	Optical Disc Company
Contact:	Someone
Address:	4444 Somewhere
City:	Someplace
State / Code:	CA 90000
Country:	USA

II. SOLUTION INFORMATION

Electroforming Solution:	Sulfamate Nickel
Tank Identification:	Sulfamate Nickle
Operating Temperature[1]:	55℃
Operating pH:	3.71
Date Sampled:	28-May-2010
Date Sumitted to Lab:	01-Jun-2010

III. ANALYTICAL RESULTS:

Bath Component	Concentration	Report Item No.
Nickel Metal	92.7 g/L (12.36 oz/gal)	1
Boric Acid	82.40 g/L (10.99 oz/gal)	2
pH (55℃)	3.71	3
Surface Tension (20℃)	69.9 dynes/cm	4
Internal Stress of Deposit	655 PSI Tensile	5

Impurities	Concentration	Report Item No.
Ammonium Ion (NH_4+)	1679 mg/L	6
Iron (Fe)	<0.01 mg/L	7
Copper (Cu)	<0.01 mg/L	8
Chromium (Cr)	<0.01 mg/L	9
Lead (Pb)	<0.01 mg/L	10
Zinc (Zn)	<0.01 mg/L	11

Recommendation Color Key:

Meets Specification / No Action Required   Potential Problem / Modification Required   Critical / Immediate Action Required

[1] If no temperature information is received with the sample, 55℃ will be assumed for testing purposes.

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SUMMARY OF RESULTS

HULL CELL DEPOSIT:

The Hull cell test consists of electrolytic deposition of nickel across a broad range of current densities to examine the expected deposit characteristics. The test uses approximately 500 mL of electroplating solution to deposit nickel on a copper cathode in an angular position to the anode (sulfur depolarized nickel). Using this method, nickel is plated at 2 amperes for 20 minutes to provide a current density range of 1.0 - 200 amps / ft^2. For more information on Hull Cell testing, please visit our web site at www.discheminc.com and go to the document titled "Hull Cell Operation" on the Technotes page. The full address for this document is http://www.discheminc.com/tece9903.pdf

Deposit Characteristics by Hull Cell Test,

2 – 200 ASF (0.2 – 21.6 A/D^2)*

HULL CELLS DEPOSIT

200 ASF 160 120 100 80 60 48 40 32 24 16 12 8 4 2

21.6 A/D^2 17.3 13.0 10.8 8.6 6.5 5.2 4.3 3.5 2.6 1.7 1.3 0.9 0.4 0.2

DisChem Analysis Report: 104837

Customer Names: G3 Mastering Solutions, Inc.

Sample ID: Sulfamate Nickle – DEPOSIT AS RECEIVED

*** ASF (amperes / foot^2) X 0.108 = A/D^2 (amperes / decimeter^2)**

Results Of Deposit Evaluation:

- The Hull Cell panel exhibits a heavy matte deposit above 16 ASF, transitioning to an irregular deposit below 12 ASF. This appearance is characteristic of high ammonium ion content in the bath.
- Slight pitting is present and is likely the result of high surface tension.

CHEMICAL CONSTITUENT ANALYSIS

ITEM NO. 1 NICKEL METAL

Nickel Metal Concentration = 92.7 g/L (12.36 oz/gal)

Method: Atomic Absorption (AA)

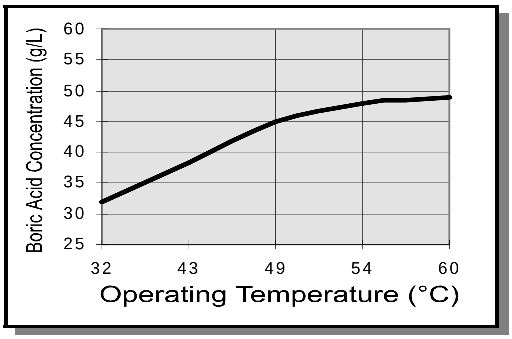
The nickel metal concentration should be maintained within the recommended range of 80 - 140 g/L. Nickel metal, in the form of nickel sulfamate, serves as the solution electrolyte. Higher nickel metal concentrations (>120 g/L) provide for greater cathode efficiency with little effect on the internal stress of the deposit. Nickel metal concentrations below 80 g/L may cause burning of the deposit due to excessive hydrogen generated at the cathode.

Recommendation: The nickel metal concentration is within the recommended range.

ITEM NO. 2 BORIC ACID

Method: Titration

Boric Acid Concentration = 82.40 g/L (10.99oz/gal)



Boric acid should be maintained at the point of saturation by temperature to prevent localized pH changes and excessive hydrogen build-up at the cathode. Boric acid may precipitate to cause rough deposits during cooling of the solution or at concentrations higher than the natural saturation point by temperature. Good filtration will prevent roughness caused by excess boric acid.

Boric Acid may be maintained in solution by suspending a polypropylene type anode bag filled with boric acid in the dummy compartment. This method allows boric to dissolve and enter the system as needed. Care should be taken not to place the dissolution bag next to a heater or an overflow as this may increase the rate of dissolution beyond that of saturation by temperature alone.

Recommendation: The boric acid is at super saturation. This is likely do to the high concentration of ammonium ion in the bath. High ammonium ion increases the solubility of boric acid in solution. Filter as need is precipitation or deposit roughness begin to occur.

ITEM NO. 3 pH

Method: ISE / ATC

Solution pH @ 55℃ = 3.71

The solution pH should be maintained within the optimum range of 3.8 - 4.4. Changes in pH affect the internal stress of deposit with the lowest point of tensile stress achieved at pH 4.0. Stress of deposit rises both above and below this point. pH slowly rises with normal use of the solution. A steadily declining pH may indicate anode passivation and should be investigated immediately.

Recommendation: The pH is low and may be an indication of anode passivation. Dummy plate to correct as needed.

ITEM NO. 4 SURFACE TENSION

Method: Stalagmometer

Surface Tension = 69.9 dynes / cm^2

The surface tension of the solution should be maintained within the recommended range of 28 - 34 dynes / cm. This range prevents pitting that can result from hydrogen generated at the cathode clinging to the deposit, yet is low enough that it does not contribute to organic contamination by wetting agents. It should be noted that only formaldehyde free wetting agents, such as DisChem's E-Liminate Pit, should be used as other formulations may cause degradation of both photoresist and NPR (non-photoresist) that may then co-deposit as organic contamination.

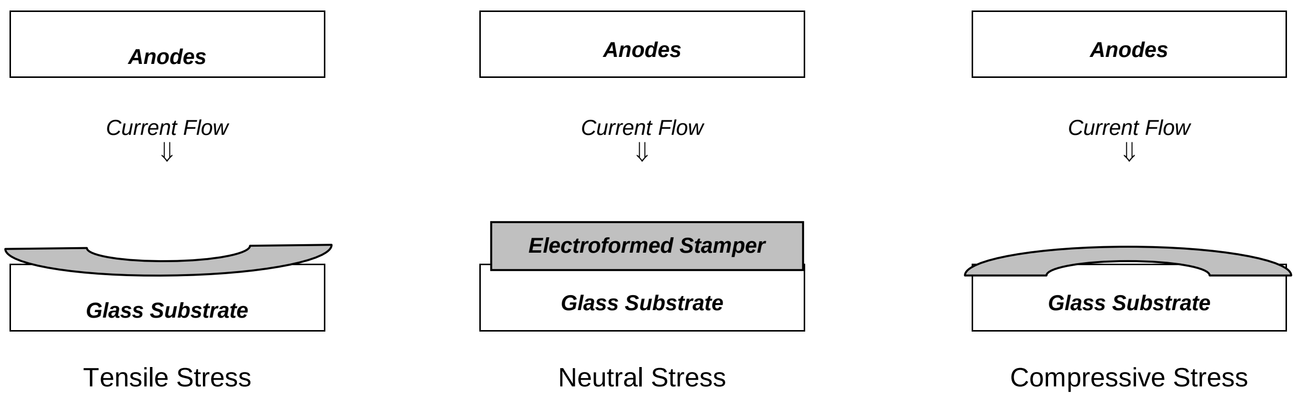
Recommendation: Little or no wetting agent is present in solution. Add Elimiinate Pit wetting agent to reduce the surface tension.

ITEM NO. 5 INTERNAL STRESS OF DEPOSIT

Method: Deposit Deflection

Internal Stress of Deposit (150 ASF) = 655 PSI Tensile

Stress should be maintained between 0 - 1000 PSI tensile (at 150 ASF) through carbon filtration and electrolytic dummy plating. Compressive stress may result from poor anode conditions, over heating, or poor maintenance of the bath. The source of the compressive stress should be identified and eliminated as this may be an indication of a more serious condition.



Recommendation: Deposit stress is within acceptable limits.

ITEM NO. 6 AMMONIUM ION

Method: Distillation

Ammonium Ion = 1679 mg/L

This breakdown product may occur over time from excessive heating, electrolysis with inactive anodes, additions of impure sulfamic acid, or hydrolysis of the nickel sulfamate. Ammonium ion levels should not exceed 1000 PPM as it contributes greatly to reduced cathode efficiency and increased tensile stress. Ammonium ion cannot be readily removed by means other than dilution.

Recommendation: Ammonium ion concentration is very high. This bath may suddenly fail due to reduced anode efficiency. Dilute or replace the bath.

ITEM NO. 7 IRON CONTAMINATION

Method: Atomic Absorption (AA)

Iron = <0.01 mg/L

Iron contamination may cause a rough plate and a darkening of the deposit, as well as increased pitting despite the presence of wetting agents. Iron will raise the internal stress of deposit approximately 1000 PSI tensile for every 300 ppm of iron present.

Recommendation: This level of iron contamination is insignificant.

ITEM NO. 8 COPPER CONTAMINATION

Method: Atomic Absorption (AA)

Copper = <0.01 mg/L

Copper contamination may cause a darkening of the deposit. Copper will raise the internal stress of deposit approximately 1000 PSI tensile for every 200 ppm of copper present.

Recommendation: This level of copper contamination is insignificant.

ITEM NO. 9 CHROMIUM CONTAMINATION

Method: Atomic Absorption (AA)

Chromium = <0.01 mg/L

Chromium contamination may cause a reduction in the cathode efficiency and increased pitting despite the presence of wetting agents. Electroform's plated with a solution containing chromium contamination may exhibit poor adhesion between the electroform and the seed layer. Chromium will raise the internal stress of deposit approximately 1000 PSI tensile for every 1 ppm of copper present.

Recommendation: This level of chromium contamination is insignificant.

ITEM NO. 10 LEAD CONTAMINATION

Method: Atomic Absorption (AA)

Lead = <0.01 mg/L

Lead contamination may cause a darkening of the deposit. Lead will raise the internal stress of deposit approximately 1000 PSI tensile for every 10 ppm of lead present.

Recommendation: This level of lead contamination is insignificant.

ITEM NO. 11 ZINC CONTAMINATION

Method: Atomic Absorption (AA)

Zinc = <0.01 mg/L

Zinc contamination may cause a darkening of the deposit. Zinc will raise the internal stress of deposit approximately 1000 PSI tensile for every 150 ppm of lead present.

Recommendation: This level of zinc contamination is insignificant.

*** END OF REPORT***

ANALYST: AMT
DATE OF REPORT: 25 AUGUST 2010
AUTHOR OF REPORT: ANDREW THOMPSON

PLEASE DIRECT QUESTIONS OR COMMENTS TO THE AUTHOR OF THE REPORT.

For additional information regarding bath maintenance, please visit our web site at http://www.discheminc.com/technotes.htm.

Thank you for using DisChem Analytical Services.