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IMPROVED PROCESS FOR THE ELECTRO DEPOSITION OF NICKEL-IRON ALLOY COATINGS ON METAL SUBSTRATES.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Safi Marg,
New Delhi-1, India, an Indian registered body incorporated
under the Registration of Societies Act (Act XXI of 1860).

The following specification describes the nature of this invention.
This is an invention by Balanjan Anantha Shenoi, Scientist; Mrs. Malathi Pushpavanam, Junior Technical Assistant and Mrs. Vidyalakshmi Raman; Junior Technical Assistant, all are Indian Nationals and are employed in the Central Electrochemical Research Institute, Karaikudi-623 006, India.

The invention relates to the improvements in or relating to the electrodeposition of Nickel-iron alloy deposit from sulfosalicylate baths.

Hitherto nickel has been used as one of the undercoats for decorative chromium deposits. In view of the scarcity and mounting cost of nickel, there is scope for replacing nickel undercoats by nickel-iron. The other baths known for nickel-iron plating give highly stressed deposits and large amount of stress relievers are to be used to get uniform and ductile deposits.

The object of this invention is to obviate these disadvantages by using iron-nickel alloy deposits in place of pure nickel and to improve the baths used for the above alloy deposition.

The main finding of the invention isthe development of a new bath for the electrodeposition of iron-nickel alloy.

This new bath will give iron-nickel alloy containing varying amounts of iron-nickel-all without the cracking of the deposit. The deposit is smooth, semi-bright and ductile.

The present invention consists of a process for the electrodeposition of iron-nickel alloy from a bath containing nickel sulfosalicylate 180 g/l, iron sulfosalicylate 70 g/l, boric acid 30 g/l, having pH 2.8 - 3.5 at 55 - 65°C.
EXAMPLE I

**Nickel sulfosalicylate**
30 g/l
180 g/l
70 g/l
2.5 - 3.5

**Sonic acid**
55 - 65°C

**Iron sulfosalicylate**
3 - 5 A/dm²

**pH**
Air agitation

**Temperature**
30%

**Current density**
11:1

**Agitation**

**Percentage of Iron in the deposit**
2 - 3 A/dm²

**Nickel : Iron anode ratio (by area)**
Mild Steel for plating

**Anode current density** and platinum for analysis.

**basis metal**

EXAMPLE II

**Nickel**
75 g/l

**Sulfosalicylic acid**
370 g/l

**Ferrous Carbonate**
30 g/l

**Boric acid**
40 g/l

**Current density**
4 - 5 A/dm²

**pH**
2 - 3

**Temperature**
50 - 60°C

**Agitation**
No

**Percentage of iron in the deposit**
15%

**Nickel : Iron anode ratio (by area)**
2 : 1

**Substrate**
Mild steel for plating and platinum of analysis.
**EXAMPLE - III**

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel sulfosalicylate</td>
<td>150 g/l</td>
</tr>
<tr>
<td>Iron sulfosalicylate</td>
<td>80 g/l</td>
</tr>
<tr>
<td>Boric acid</td>
<td>40 g/l</td>
</tr>
<tr>
<td>Current density</td>
<td>3 - 4 A/dm²</td>
</tr>
<tr>
<td>PH</td>
<td>3 - 3.5</td>
</tr>
<tr>
<td>Temperature</td>
<td>60 - 70°C</td>
</tr>
<tr>
<td>Agitation</td>
<td>air agitation near anode</td>
</tr>
<tr>
<td>Nickel : Iron anode ratio (by area)</td>
<td>1 : 1</td>
</tr>
<tr>
<td>Percentage iron in the deposit substrate</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>Mild Steel for plating and Platinum for analysis.</td>
</tr>
</tbody>
</table>

The following are the main advantages of this invention.

Semi bright, smooth deposits equivalent to pure nickel deposits are obtained. This can be used as a substitute for pure matte nickel plating.

Iron-nickel deposits containing 10 - 35% iron can be obtained from a bath containing nickel sulfosalicylate 150 - 200 g/l. Iron sulfosalicylate 30 - 80 g/l boric acid 30 - 50 g/l using nickel and iron dual anode at the ratio in the range of 2:1 - 1:1 at 55 - 65°C, pH 2.5 - 3.5 at 3 - 7 A/dm² with or without air agitation.

Dated this 22nd day of December, 1979

\[\text{Signed}\]

(I.M.S.KAMAK)

PATENTS OFFICER

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
COMPLETE SPECIFICATION

(SECTION—10)

IMPROVED PROCESS FOR THE ELECTRO DEPOSITION OF NICKEL-IRON ALLOY COATINGS ON METAL SUBSTRATES.

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Rafi Marg, New Delhi-1, India, an Indian registered body incorporated under the Registration of Societies Act (Act XXI of 1860)

The following specification particularly describes and ascertains the nature of this invention and the manner in which it is to be performed:—
This is an invention by Balkunja Anantha Shenu, Scientist; Mrs. Malathy Pushpavanan, Junior Technical Assistant and Mrs. Vidyakshmi Raman, Junior Technical Assistant, all are employed in the Central Electrochemical Research Institute, Karaikudi - 623 006, India - and all are Indian nationals.

This invention relates to an improved process for the electrodeposition of nickel-iron alloy coatings on metal substrates. The metal substrates used are of mild steel, copper or brass.

Hitherto nickel-iron alloy has been deposited from an electrolytic bath containing sulfate-chloride or sulfate-bath in the presence of additional components like trisodium citrate.

The object of this invention is to develop an improved electrolytic bath for nickel-iron alloy deposition of coatings wherein the stress in the alloy coatings obtained can be reduced without adding further additive to the bath as stress relievers.

The main finding of the invention is the development of the improved bath for nickel iron alloy deposition wherein we don't require any additional complexing agent and the internal stress of the alloy is also less.

Normally used process for obtaining nickel-iron alloy coatings by electrodeposition on the substrates comprises the steps of mechanically polishing the substrates, degreasing the same, alkaline cleaning and pickling followed by electroplating the substrate in a chemical electrolytic bath as stated above.

Nickel iron plating is finding application as a way of substituting the nickel. But the alloy has a slightly high internal stress for which a greater amount of stress relievers are added to minimize the stress. Moreover to keep the iron in solution, additional complexing agents are also added. By the development of this improved bath, we don't require any other complexant and we could get less stressed deposit with the same hardness value.
Semi bright, smooth deposits similar to nickel deposits are obtained in which the internal stress is slightly less than other sulfate chloride baths.

The process of the present invention consists in the electro deposition of nickel-iron alloy coatings on metal substrates from a bath containing salt of nickel, sulfosalicylic acid or nickel sulfosalicylate, iron sulfosalicylate, and boric acid at having pH of 2.8 - 3.5.

Iron nickel alloy deposits containing 10-35% iron can be obtained from a bath containing nickel sulfosalicylate 150-200 g/l iron sulfosalicylate 50-80 g/l, boric acid 30-50 g/l, using nickel and iron dual anode at the ratio of 2:1 - 1:1 at 55-65°C, pH 2.8 - 3.5 at 3-7 A/dm² with or without agitation.

Accordingly the invention provides an improved process for the electrodeposition of nickel-iron alloy coatings on metal substrates which comprises electrodepositing the substrates in an electrolytic bath consisting of sulfosalicylic acid salts of nickel and iron and boric acid maintained at pH of 2 to 3.5 and a temperature of 50 to 65°C.

According to a feature of the invention the electrolytic bath consists of nickel sulfosalicylate, iron sulfosalicylate and boric acid.

According to another feature of the invention the electrolytic bath consists of 180 g/l of nickel sulfosalicylate, 70 g/l of iron sulfosalicylate and 50 g/l of boric acid and the bath is maintained at a pH of 2.8 to 3.5 and a temperature of 55-65°C with an agitation.

According to a further feature of the invention the electrolytic bath consists of 200 g/l of nickel sulfosalicylate, 50 g/l of iron sulfosalicylate and 50 g/l of boric acid and the bath is maintained at a pH of 3.5 and a temperature of 65°C with-
-out agitation.

According to another further feature of the invention the electrodeposition is carried out at 3-5 A/dm² with nickel and iron anodes in the ratio of 2:1 to 1:1.

Thus the process for the electrodeposition of nickel-iron alloy coatings on copper, brass or steel substrates consists in using a bath containing nickel sulfosalicylate 180 g/l, iron sulfosalicylate 70 g/l, boric acid 30 g/l with nickel and iron anodes in the ratio of 1:1 at 60°C at pH 3 with air agitation wherein we get an alloy containing 30% iron.

The process for the electrodeposition of nickel iron alloy deposits on copper, brass or steel substrate preferably a bath containing nickel sulfosalicylate 180 g/l, iron sulfosalicylate 70 g/l, boric acid 30 g/l with nickel and iron anodes in the ratio of 1:1 at 60°C at pH 3 with or without agitation wherein we get alloy deposits having 15-30% iron.

The invention is further illustrated by the following examples:

**Example 1**

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel sulfosalicylate</td>
<td>180 g/l</td>
</tr>
<tr>
<td>Boric acid</td>
<td>30 g/l</td>
</tr>
<tr>
<td>Iron sulfosalicylate</td>
<td>70 g/l</td>
</tr>
<tr>
<td>pH</td>
<td>2.5 - 3.5</td>
</tr>
<tr>
<td>Temperature</td>
<td>55- 65°C</td>
</tr>
<tr>
<td>Current density</td>
<td>3-5 A/dm²</td>
</tr>
<tr>
<td>Agitation</td>
<td>By air</td>
</tr>
<tr>
<td>Percent iron in the alloy</td>
<td>30%</td>
</tr>
<tr>
<td>Nickel iron anode ratio(by area)</td>
<td>1:1</td>
</tr>
<tr>
<td>Anode current density</td>
<td>2-3 A/dm²</td>
</tr>
<tr>
<td>Anode current density for nickel</td>
<td>1 - 1.5 A/dm²</td>
</tr>
<tr>
<td>Anode current density for iron</td>
<td>1 - 1.5 A/dm²</td>
</tr>
<tr>
<td>Basis metal</td>
<td>Mild steel, copper or brass</td>
</tr>
<tr>
<td>Cathodic efficiency</td>
<td>82%</td>
</tr>
</tbody>
</table>
### Example 2

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel carbonate</td>
<td>75 g/l</td>
</tr>
<tr>
<td>Sulfosalicylic acid</td>
<td>370 g/l</td>
</tr>
<tr>
<td>Ferrous carbonate</td>
<td>30 g/l</td>
</tr>
<tr>
<td>Boric acid</td>
<td>40 g/l</td>
</tr>
<tr>
<td>Current density</td>
<td>4-5 A/dm²</td>
</tr>
<tr>
<td>pH</td>
<td>2-3</td>
</tr>
<tr>
<td>Temperature</td>
<td>50-60 °C</td>
</tr>
<tr>
<td>Agitation</td>
<td>No</td>
</tr>
<tr>
<td>Percentage of iron in the alloy</td>
<td>15%</td>
</tr>
<tr>
<td>Cathodic efficiency</td>
<td>92%</td>
</tr>
<tr>
<td>Nickel: iron anode ratio (by area)</td>
<td>2:1</td>
</tr>
<tr>
<td>Anode current density</td>
<td>2.5 - 3.5 A/dm²</td>
</tr>
<tr>
<td>Anode current density for nickel</td>
<td>1.6 - 2.3 A/dm²</td>
</tr>
<tr>
<td>Anode current density for iron</td>
<td>0.8 - 1.16 A/dm²</td>
</tr>
<tr>
<td>Substrate</td>
<td>Mild steel, copper or brass.</td>
</tr>
</tbody>
</table>

Semi bright nickel-iron alloy coatings obtained contain 15-30% iron and have less stress value than the coatings obtained from other known baths.

The bath used in the process of this invention has been thus modified by additive of sulfosalicylate so that semi bright and less stressed deposits could be obtained.
1. An improved process for the electrodeposition of nickel-iron alloy coatings on metal substrates comprising electroplating the substrates in an electrolytic bath consisting of sulfosalicylic acid salts of nickel and iron; and boric acid maintained at pH of 2 to 3.5 and a temperature of 50 to 55°C.

2. Process as claimed in claim 1 wherein the electrolytic bath consists of 180 g/l of nickel sulfosalicylate, 70 g/l of iron sulfosalicylate and 30 g/l of boric acid and the bath is maintained at a pH of 2.8 to 3.5 and a temperature of 55-60°C with an agitation.

3. Process as claimed in claim 1 wherein the electrolytic bath consists of 200 g/l of nickel sulfosalicylate, 50 g/l of iron sulfosalicylate and 50 g/l of boric acid and the bath is maintained at a pH of 3.5 and a temperature of 65°C without agitation.

4. Process as claimed in any of the preceding claims wherein the electrodeposition is carried out at 3-5 A/dm² with nickel and iron anodes in the ratio of 2:1 to 1:1.

5. An improved process for the electrodeposition of nickel-iron alloys coating on metal substrates substantially as described and illustrated herein.

Dated this 20th day of December, 1980.

[Signature]

(I.M.S.Baker)  
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