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Study of Nickel Plating Electrolysis Process on Mild Steel Material

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ABSTRACT

Nickel plating is used for decorative, engineering, and electroforming purposes. The typical base metals for nickel plating are steel, copper alloys, and zinc alloys. Steel and copper alloy substrates are usually plated directly, but copper underplating is required for plating on zinc. Stainless steel, aluminum, magnesium, and plastics can also be nickel plated, but they require special treatment before plating. Nickel coatings for engineering applications are usually smooth and matt, while the decorative coatings are lustrous, smooth, and bright. Bright nickel coatings are plated with thin chromium coating to prevent nickel tarnishing

INTRODUCTION:

Nickel electroplating was developed in the first half of the 19th century, with notable experiments made by Golding Bird (1837) and nickel nitrate patent by Joseph Shore (1840). The first practical recipe, an aqueous solution of nickel and ammonium sulfates, was invented by Böttger in 1843 and was in use for 70 years[1].The commercial success was achieved by Isaac Adams Jr., whose patent for a solution of nickel ammonium sulfate, while similar to Böttger's, had neutral pH that made the process easier to control. Adams enjoyed a near-monopoly in nickel plating from 1869 to 1886, when the consumption of nickel for plating reached 135 tons[2].In the US, Remington tried to use the nickel ammonium chloride solution (1868), in the process establishing the anode construction in the form of a platinum basket filled with nickel pieces,Edward Weston initiated the use of boric acid (patent issued in 1878),Bancroft figured out the role of chlorides in dissolving the anode (1906)[3].Nickel electroplating is a process of depositing nickel onto a metal part. Parts to be plated must be clean and free of dirt, corrosion, and defects before plating can begin.To clean and protect the part during the plating process, a combination of heat treating, cleaning, masking, pickling, and etching may be used.Once the piece has been prepared it is immersed into an electrolyte solution and is used as the cathode[4]. The nickel anode is dissolved into the electrolyte to form nickel ions (Ni2+). Just like in other electrodeposition processes, the ions travel through the solution and deposit on the cathode[5].

The anode efficiency for nickel dissolution is close to 100%, unless the anode becomes passive due to problems with the process, in which case the efficiency drops to 0. The cathode efficiency depends on the process and varies between 90 and 97%. Due to this mismatch, during the plating the nickel concentration in the solution and the pH will slowly rise.The process takes minutes to hours depending on the current density and the intended thickness of the plating.

MATERIALS AND METHODS:

Watts Baths**:**
A Watts bath, named for its inventor Oliver Patterson Watts, is an aqueous electrolyte solution for plating nickel from a nickel anode. It can deposit both bright and semi-bright nickel. Bright nickel is typically used for decorative purposes

Chemical Name	Formula	Bright[11]		Semi-bright[11]	
		Metric	US	Metric	US
Nickel sulfate	$NiSO_4 \cdot 6H_2O$	150–300 g/L	20–40 oz/gal	225–300 g/L	30–40 oz/gal
Nickel chloride	$NiCl_2 \cdot 6H_2O$	60–150 g/L	8–20 oz/gal	30–45 g/L	4–6 oz/gal
Boric acid	H_3BO_3	37–52 g/L	5–7 oz/gal	37–52 g/L	5–7 oz/gal

and corrosion protection. Semi-bright deposits are used for engineering applications where high corrosion resistance, ductility or electrical conductivity is important, and a high luster is not required.
Operating Conditions:

- Temperature: 40-65 °C
- Cathode current density: 2-10 A/dm2
- pH: 4.5-5

Brighteners:

- Carrier brighteners (e.g. paratoluene sulfonamide, benzene sulphonic acid) in concentration 0.75-23 g/L. Carrier brighteners contain sulfur providing uniform fine grain structure of the nickel plating.
- Levelers, second class brighteners (e.g. allyl sulfonic acid, formaldehyde chloral hydrate) in concentration 0.0045-0.15 g/L produce (in combination with carrier brighteners) brilliant deposit.
- Auxiliary brighteners (e.g. sodium allyl sulfonate, pyridinium propyl sulfonate) in concentration 0.075-3.8 g/L.
- Inorganic brighteners (e.g. cobalt, zinc) in concentration 0.075-3.8 g/L. Inorganic brighteners impart additional lustre to the coating.
- Type of the added brighteners and their concentrations determine the deposit appearance: brilliant, bright, semi-bright, satin.

SAMPLE PREPARATION:

The steps for nickel electroplating are:

- Prepare the sample: The sample to be plated is immersed in an electrolyte solution and acts as the cathode.
- Dissolve the nickel anode: A nickel anode is dissolved into the electrolyte to create nickel ions.
- Connect the anode and cathode: Hang a piece of nickel over the container as the anode and dangle the part to be plated into the electrolyte. Connect the negative to the part and the positive to the nickel anode.
- Power up: Turn on the power and bubbles should appear on the part.
- Leave in the bath: The item should be left in the bath for a minimum of 40 minutes and a maximum of 60 minutes. The longer the item is in the bath, the thicker the nickel coating will be.

Some tips for nickel electroplating include:

- Use a 6V battery or a lower voltage to achieve a smoother, shinier finish.
- Set the rectifier to 1.5–2 volts and the solution to 120–140º F.
- Use nickel sulfate as the electrolyte

RESULTS:

- Improved appearance: Nickel plating can make a material brighter and improve its physical appearance. The finish matte, satin, or shiny, depending on the chemicals and process used.
- Increased strength and hardness: Nickel plating can improve the strength and hardness of the material.
- Better wear resistance: Nickel plating can improve the wear resistance of the material.
- Increased corrosion resistance: Nickel plating can increase the corrosion resistance of the material.
- Even coating: Electroless nickel plating can create a uniform layer of nickel on a substrate, which is ideal for components with complex shapes.
- Base layer for other metals: Nickel plating is often used as a base layer for gold or silver.

CONCLUSION:

Nickel plating provides a unique combination of corrosion and wear resistance. It can add brightness, lustre and appeal. It also provides excellent adhesion properties for subsequent coating layers, which is why nickel is often used as an 'undercoat' for other coatings, such as chromium.

REFERENCES:

- Di Bari, George A. (14 February 2011). "Electrodeposition of nickel" (PDF). In Mordechay Schlesinger; Milan Paunovic (eds.). Modern Electroplating (5 ed.). John Wiley & Sons. Pp. 79–114. ISBN 978-1-118-06314-9. OCLC 1037918105.
- Dubpernell, George (1959). "The story of nickel plating" [reprinted in Plating & Surface Finishing, April 2006, pp. 34-43] (PDF). Plating. 46 (6): 599–616.
- Nebiolo, William P. (August 2022). "The History of Electroplating And A Historical Review of the Evolution of NASF" (PDF). NASF Surface Technology White Papers. 86 (11). NASF: 1–14.
- Magdy A. M. (2005). "Black nickel electrodeposition from a modified Watts bath". Journal of Applied Electrochemistry. 36 (3): 295–301. doi:10.1007/s10800-005-9077-8. ISSN 0021-891X. S2CID 95324802.
- "MIL-P-18317 PLATING BLACK NICKEL ON BRASS BRONZE ".