

Practical Work n°2:

Chemical copper plating and autocatalytic nickel plating on iron

1-OBJECTIVES

- * Perform a chemical copper deposition on iron
- * Perform a chemical nickel deposition without an electric current
- * Understanding the mechanism of chemical reduction
- * Compare the properties of the two coatings
- * Study the adhesion and appearance of the deposits

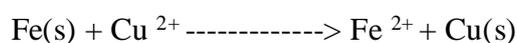
2-THEORETICAL PRINCIPLE

A. Chemical copper plating

Chemical copper plating involves depositing metallic copper onto iron through a spontaneous redox reaction.

Copper sulfate (CuSO_4) is generally used .

Displacement reaction:



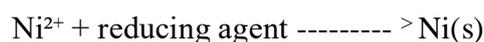
The iron oxidizes and copper is deposited on its surface.

B. Autocatalytic nickel plating

Chemical nickel plating is a reduction of Ni^{2+} ions to metallic nickel without electric current.

Nickel chloride (NiCl_2) or nickel sulfate is often used , with a reducing agent such as sodium borohydride.

Reduction:



With NaBH_4 \rightarrow formation of a Nickel–Boron (Ni–B) deposit.

3- MATERIALS AND REAGENTS

Material

- Beakers (250 mL), Thermometer, Analytical balance,
- Magnetic stirrer, pH meter or pH paper, iron plates, water bath

Reagents**For copper plating:**

- Copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$)
- Diluted hydrochloric acid (pickling)
- Distilled water

For nickel plating:

- Nickel chloride (NiCl_2)
- Sodium borohydride (NaBH_4)
- Sodium hydroxide (NaOH), Water distilled

4-Operating conditions

<u>Parameter</u>	<u>Copper plating</u>	<u>Nickel plating</u>
Temperature	25 °C	40–60 °C
pH	Neutral	12–13
Time	5–15 min	20–40 min
Agitation	Moderate	Continuous

5- Sample preparation

1. Lightly sand the iron
2. Degreasing (alcohol or acetone)
3. Rapid pickling in dilute HCl
4. Rinse with distilled water and dry

6-EXPERIMENTAL PROTOCOL**Part A: Chemical Copper Plating**

1. CuSO_4 (0.5 M) solution.
2. Immerse the clean iron plate in the solution.
3. Observe the reddish copper deposit.
4. Remove after 10 minutes, then rinse and dry.

Observation :

- Appearance of a red/orange deposit
- The solution becomes slightly greenish (Fe^{2+} formed)

Part B: Autocatalytic nickel plating

1. Prepare 100 mL of NiCl_2 (0.1 M) solution.
2. Adjust the pH to 12 with NaOH.

3. Heat to 50°C.
4. Insert the iron plate.
5. Slowly add NaBH₄ while stirring.
6. Maintain for 30 minutes.
7. Rinse and dry.

Observation :

- Metallic grey/black deposit
- Release of bubbles (H₂)

7- EXPECTED RESULTS

Criterion	Copper plating	Nickel plating
Color	Red	Metallic Gray
Uniformity	Average	Very uniform
Hardness	Low	High
Corrosion resistance	Medium	High

8- Interpretation

- Copper plating is a simple displacement reaction.
- Nickel plating is a controlled chemical reduction.
- Nickel plating provides a harder and more protective coating.

QUESTIONS

1. Why is copper plating a spontaneous reaction?
2. Why does the pH need to be high for nickel plating with NaBH₄ ?
3. Compare the two types of deposit.
4. Which coating is best suited to protect iron against corrosion?
5. Conclusion