Experiment Time: 2019 / 05 / 28 14 : 00 ~ 16 : 30 Laboratory: DS2B402

Experimental Report

Experiment Course Title: Experimental of College Chemistry I

Experimental Project Name:

A: Electrochemistry and Oxidation Reduction

B: Metal corrosion and corrosion protection

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College: JCI Specialty: Mechanical Engineering

Class: ME01 Mentor: Chen Gang

Score:

Teacher Comments:

1. Purpose

Experiment A

(1) Deepen the understanding of the electrode potential and the principle of electrolysis.

(2) Understanding the application of electrolysis principle in electropolishing.

(3) Familiar with the polishing process.

Experiment B

(1) Understanding plating principles and methods.

(2) Understand plating process.

2. Principle and Method

(1) **Experiment A: Electropolishing:**

The dissolution rate of the protruding part on the anode metal surface is larger than that of the concave part. After a period of electrolysis, the surface is smooth and shiny.

Take steel as an example: During the electropolishing, workpiece is anode as well as lead plate is cathode. Put them into electrolyte which is made up of chromic anhydride, phosphoric acid and sulphuric acid. Here are the chemical equations.

Anode equations :

$$Fe = Fe^{2+} + 2e^-$$

$$6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ = 6Fe^{3+} + 2Cr^{3+} + 7H_2O$$

Cathode equations:

Fe^{3+} reacts with HPO_4^{2-} and SO_4^{2-}, then generates $Fe_2(HPO_4)_3$ and $Fe_2(SO_4)_3$. As the electrolysis progresses, the concentration of the salts around the anode increases continuously, forming a kind of sticky flm on the metal surface, which increases the concentration of the electrolyte and reduces the conductivity. Due to uneven distribution of liquid film thickness and thick part of concave film, the current density is small, and Fe is not easy to dissolve and is passivated. The raised part of the film is thin, the current density is large, and the Fe is easy to dissolve and active. The convex part dissolves faster than concave part, and the roough surface becomes smooth.

$$2H^+ + 2e^- = H_2(g)$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- = 2Cr^{3+} + 7H_2O$$

(2) **Experiment B: Metal Plating:**

The method of depositing a layer of metal on the surface of a metal or nonmetal workpiece by electrochemical process is called electroplating. The technology is widely used in various production and research departments of the national economy. The main function of electroplated coating is to improve the corrosion resistance of metal parts in the working environment. Decorate the appearance of the work piece, make it bright and beautiful. Improve work performance.

2. Materials and Instruments

Experiment A: Electropolishing:

(1) Instrument:

DC regulated power supply, three electrolytic cells, two thermometers.

(2) Materials:

HCl(1.9g.dm-3), H2SO4(1.84g.cm-3), H3PO4(1.7g.cm-3), glycerin, NaOH(s), Na2CO3(s), Na2CO3(s), CrO3(s).

Experiment B: Metal Plating:

Instrument:

DC regulated power supply, two copper pieces, two nickel pieces, beaker, electric furnace, sand paper, glass rod, wire.

(2) Materials:

Alkali wash: Na2CO3(25-30g.dm-3), NaOH(25-30g.dm-3)

Pickled: H2SO4(6mol.dm-3)

Plating: NiSO4(140g.dm-3), MgSO4(30g.dm-3), Na2SO4(50g.dm-3), H2BO3(20g.dm-3), NaCl(5g.dm-3)

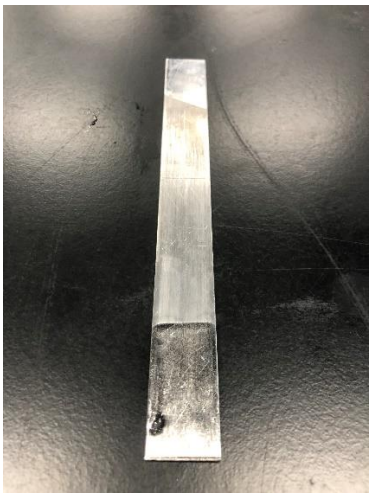
4. Experimental Records and Calculation

Experiment A:

(1) Unoil: Anode: 2 steel sheet
Cathode: workpiece
→ degreasing solution 60℃, heater setting 120℃ → Cathode 0.5A, 2.4V 10min → clean the workpiece

Expression: There are plenty of bubbles on the surface of workpiece.（Graph 1）

Graph 1



Graph 2

(2) Pickling: workpiece → 40℃ acid solution 5min, 0.6A 3.1V → wash by H_2O

Expression: Sparse bubbles on the surface of the work piece. （Graph 2）

(3) Polishing: Anode: workpiece
Cathode: 2 zinc plate
→ Polishing solution 70℃, heater → Anode 0.6A 3.1V, 10min → get the product

Expression: The surface of the workpiece is flashy and smooth.(Graph 3 & Graph 4)

Anode: $Fe = Fe^{2+} + 2e^-$ $\quad 6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ = 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

Cathode: $2H^+ + 2e^- = H_2(g)$ $\quad Cr_2O_7^{2-} + 14H^+ + 6e^- = 2Cr^{3+} + 7H_2O$

Graph 3

Graph 4

(1) Grinding the copper workpiece with sand paper.

Expression: Get rid of rust stain and the surface is smooth.(Graph 5)

Graph 5

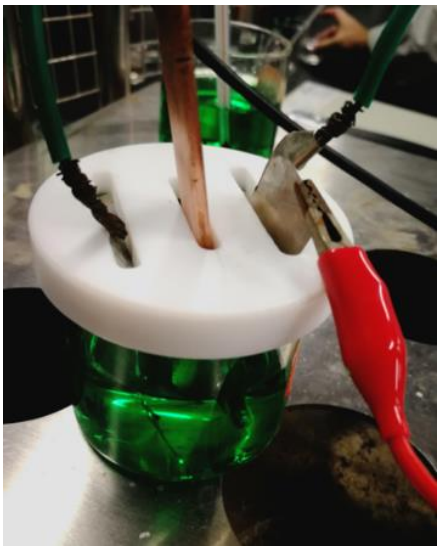
(2) Wash the workpiece $\xrightarrow[60℃\ \text{stir}\ \ 10\text{min}]{\text{degreasing solution}}$ wash $\xrightarrow[\text{stir}\ 1\text{min}]{\text{acid solution}}$ wash

(3) Anode: 2 nickle sheet
Cathode: workpiece
$\xrightarrow[0.1\text{A}\ \ 1.2\text{V}\ \ 10\text{min}]{\text{plating solution}\ \ 40℃}$ $\xrightarrow[\text{wash}]{\text{turn off the power}}$ get the production

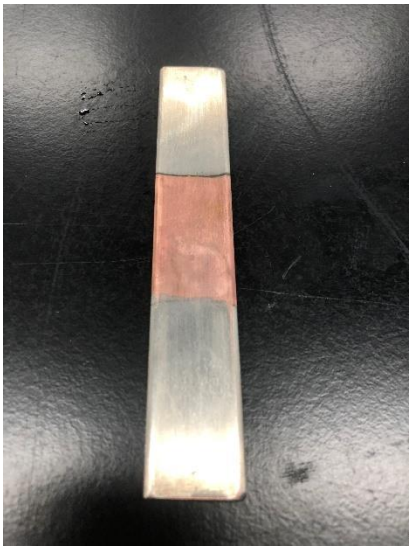
Expression: Sparse bubbles are on the surface. The surface of copper(workpiece) is plated by nickel.
(Graph 6 & Graph 7)

Cathode: $Ni^{2+}+2e^{-}\rightarrow Ni$ $\quad 2H^{+}+2e^{-}\rightarrow H_2\uparrow$

Anode: $Ni-2e^{-}\rightarrow Ni^{2+}$



Graph 6



Graph 7

5. Results and Discussion

(1) What is the principle of electropolishing?

It takes the metal products suspended in the electrolytic tank as the anode, electrolysis under specific conditions, through the dissolution of the anode metal, the surface of the products to eliminate fine uneven.

(2) What are the similarities and differences between electropolishing and electrochemical machining?

Similarity: Both of them do the anodic dissolution to work.

Difference: Electropolishing is aimed to make the surface of workpiece smooth while electrochemical machining is used to shape the shape and size of.

(3) What are the roles of the main components in polishing fluid for electropolishing?

1. H_3PO_4 and H_2SO_4 are added to adjust the PH value of the polishing fluid to ensure the chemical reaction during the polishing process

2. CrO_3 is used as oxidizing agent

3. Glycerin is added to the polishing fluid to improve its dispersion stability and reduce the agglomeration of abrasive particles.

(4) Why should the workpiece be polished, alkali washed, and acid washed before electroplating?

Polishing: Remove stains and make surface relatively smooth.

Alkali washed: Remove grease on surface.

Acid washed: Remove rust on surface.

(5) What are the factors related to the quality of the coating?

1.Temperature 2. Current 3. PH in solution 4. Time for metal plating 5. current density

(6) In order to ensure the quality of coating, what problems should be paid attention to in the process of experiment operation?

1. Strictly control the process parameters (such as temperature, current density, PH value, plating time, etc.).
2. Pretreatment must be done well. Preparation is important.