International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 12 | Dec - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Study of Copper Electro Plating Electrolysis Process on Mild Steel Material

Chandrashekharaiah S B[1*], Khamar Taj[2], Ananda C B[3]

[1*] Senior Grade Lecturer, Dept of Machine Tool Technology, Smt. L. V. Govt. Polytechnic, Hassan-573201.

[2] Senior Grade Lecturer, Dept. of Automobile Engineering, S J Government Polytechnic, Bangalore-560001.

[3] Senior Grade Lecturer, Dept. of Mechanical Engineering, Government Polytechnic, Ramanagar-562159.

ABSTRACT

Copper plating or copper electroplating is a massive industry that is rising enormously across the globe. It is considered a highly refined and effective method in the metal coating industry. However, copper in itself is very expensive because of the limited supply and high demand. The reason the demand for copper is high is that it is a vital component used for everything from plumbing, wiring, electronics to industrial fertilizers and pesticides. Copper is considered a miracle metal because of its unique properties this metal is malleable, it conducts electricity, resists corrosion and the best part is it can easily take on a variety of shapes

INTRODUCTION:

Copper electroplating is done through the use of electricity or bypassing electric current in a solution called an electrolyte. In copper electroplating solution, a container of water with the copper rod and the item that needs copper plating is placed[1]. This water contains an ionic solution that helps the electricity to flow directly from the copper rod to the plating item[2]. By dipping two electrodes into the electrolyte and connecting it to a circuit with electricity or a battery, it dissolves the copper rod and physically transports the copper ions to the item that needs the plating[3]. Hence, a thin, solid, metallic copper film or coating is formed on the surface of the item[4]. In short, the concept of copper electroplating solution is – when an item is submerged into an electrolyte bath, where electricity is directly applied to make the copper ions migrate and deposit on the surface of the metal that needs copper plating[5].

MATERIALS AND METHODS:

Plating Capabilities and Methods
We are capable of applying copper coatings of various thicknesses to a range of base materials and product types. Some of the methods we use include:

Electroplating: In copper electroplating, a metal substrate is placed in an electrolytic bath and an electric current is used to cause copper ions to adhere to the base material's surface. The result is a thin copper coating on the surface.
Barrel plating: This highly efficient type of electroplating allows SPC to copper plate many smaller parts at the same time. To create the best results, SPC designs the majority of barrel plating equipment in-house.
Electroless plating: Electroless plating uses a purely chemical process, without an external energy source, to create a metal coating. This method produces coatings that tend to be less porous and more resistant to corrosion, making it ideal for products that will be exposed to challenging conditions.
Rack electroplating: Rack electroplating is recommended when plating specifications are complicated and strict testing requirements must be met. We can accommodate prototype volumes as well as mass production.
Heavy build plating: Heavy build plating creates a thicker coating than other methods. Heavy build plating typically has a thickness exceeding 0.001 inches. For example, plated ammunition often features 0.020-inch thick heavy build plating..
Types Of Plating Chemistries:
There are a variety of different electrolyte chemistries that can be used for copper electroplating, but most can be broadly characterized into five general categories based on the complexing agent:

- Alkaline cyanide
- Alkaline non-cyanide
- Acid sulfate
- Acid fluoroborate
- Pyrophosphate

Alkaline cyanide:

Alkaline cyanide baths have historically been one of the most commonly-used plating chemistries for copper electrodeposition. Cyanide copper baths typically provide high covering and throwing power, allowing uniform and complete coverage of the substrate, but often plate at lower current efficiency. They produce a metal finish favored for its diffusion blocking character. Diffusion blocking is used to improve the long term adherence of different metals, e.g. chromium and steel. It is also used to prevent the second material from diffusing into the substrate.Cyanide baths contain cuprous cyanide as the source of copper(I) ions, sodium or potassium cyanide as a source of free cyanide that complexes with cuprous cyanide to render it soluble, and sodium or potassium hydroxide for increased conductivity and pH control. Baths may also contain Rochelle salts and sodium or potassium carbonate, as well as a variety of proprietary additives. Cyanide copper baths can be used as low-efficiency strike-only baths, medium-efficiency strike-plate baths, and high efficiency plating baths.

Chemical Name	Formula	Strike[6]		Strike-plate[6]		High-efficiency plate[6]	
		Sodium	Potassium	Sodium	Potassium	Sodium	Potassium
Copper(I) cyanide	CuCN	30 g/L	30 g/L	42 g/L	42 g/L	75 g/L	60 g/L
Sodium or potassium cyanide	NaCN or KCN	48 g/L	58.5 g/L	51.9 g/L	66.6 g/L	97.5 g/L	102 g/L
Sodium or potassium hydroxide	NaOH or KOH	3.75–7.5 g/L	3.75–7.5 g/L	Control to pH 10.2–10.5		15 g/L	15 g/L
Rochelle salts	$KNaC_4H_4O_6{\cdot}4H_2O$	30 g/L	30 g/L	60 g/L	60 g/L	45 g/L	45 g/L
Sodium or potassium carbonate	Na_2CO_3 or K_2CO_3	15 g/L	15 g/L	30 g/L	30 g/L	15 g/L	15 g/L

Bath Composition:

Operating Conditions:

- Temperature: 24-66 °C (strike); 40-55 °C (strike-plate); 60-71 °C (high-efficiency)
- Cathode current density: 0.5-4.0 A/dm2 (strike); 1.0-1.5 A/dm2 (strike-plate); 8.6 A/dm2 (high-efficiency)
- Current efficiency: 30-60% (strike); 30-50% (strike-plate); 90-99% (high-efficiency);
- pH: >11.0

Toxicity:

Commercial platers typically use a copper cyanide solution, which retains a high concentration of copper. However, the presence of free cyanide in the baths makes them dangerous due to the highly toxic nature of cyanide. This creates both health hazards as well as issues with waste disposal.

SAMPLE PREPARATION:

How Copper Plating Solution Works:

STEP 1:

Choosing the right electrolyte and the right electrodes is the first step towards electroplating. So, for copper plating an electrolyte that is made from a solution of copper salt is necessary.

STEP 2:

The next step is to check that the electrode is completely clean and this can be done by dipping the electrode into an alkaline solution or a strong acid to make it dirt-free. This is an important step because if the electrode is not clean, then the copper atoms will not form a good bond on it and may erode or rub off. Hence, when the electrode is clean it will help the copper atoms to effectively bond on it and keep the copper plating strong and intact.

STEP 3:

Once the electrode is clean, then comes the actual process of electroplating. For this we require 1) Two electrodes which are of different conducting materials, 2) An electrolyte or the solution containing the salt of copper, and 3) A battery or an electricity supply. For example, since here we are focusing on copper electroplating and if we want copper plating on a piece of iron, then we need a copper electrode, an iron electrode that is clean, and a solution of copper salt like copper sulfate solution. In this process the copper becomes the positive electrode or it is also called the anode and the iron becomes the negative electrode or as it is called the cathode.

STEP 4:

In this final step, once the two types of electrodes are dipped in the solution then comes the next step of connecting it to electricity. So, as soon as the setup is ready, electricity is passed and the copper sulfate solution splits into ions and gets attracted to the iron electrode, which slowly deposits a thin layer of copper plating on it. Copper electroplating takes time and it mostly depends on the concentration of the electrolyte and the strength of the electricity.

RESULTS:

Copper plating is an economical and low-maintenance solution to many metal surface finishing needs. Its ability to provide corrosion protection, electrical conductivity, heat transfer capabilities, and decorative finish makes it a popular choice for industrial, commercial, and consumer applications. The use of bare copper wire provides similar benefits but with the added advantage of being very cost-effective due to its low price per unit compared to other materials like aluminum or steel. In addition, installation costs associated with using bare copper wires tend to be much lower than those associated with more complex processes such as electroplating or chemical plating

CONCLUSION:

Electroplating (also referred to as Electrodeposition) is plating or depositing one metal onto the other through hydrolysis, which helps stop or minimize metals' corrosion. In this process, a thin layer of the desired metal will be deposited on the surface of the target metal. Electric current is used to decrease the number of dissolved metals to develop a thin, coherent metal coating on the electrode.

REFERENCES:

1. Horner, Jack. "Cyanide Copper Plating" (PDF). Plating & Surface Finishing. Retrieved July 24, 2022.
2. "ACIDIC COPPER PLATING". Consonni S.R.L. Retrieved July 26, 2022.
3. "Acid Copper Plating Tank". Think & Tinker, Ltd. Retrieved July 26, 2022.
4. "Acid Copper Through-hole Plating". Think & Tinker, Ltd. Retrieved July 26, 2022.
5. Passal, Frank (1959). "A look back in plating & surface finishing: Copper plating (1909-1959)" (PDF). Plating. 46 (6): 628.