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# Electrolytic Corrosion Resistant Plating for Connector Pins

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## ABSTRACT

This disclosure describes an electroplating configuration that is resistant to electrolytic corrosion. The configuration is a stack-up of different layers that include copper (Cu) layer surrounding the substrate, a nickel (Ni) layer, and a nickel-tungsten (NiW) layer. The configuration additionally includes a gold (Au) layer utilized as an interface layer between the NiW layer and an outer rhodium-ruthenium (RhRu) layer. To impart electrolytic corrosion resistance, a rhodium-ruthenium (RhRu) layer is electroplated as an outer layer. The electroplating stack-up described in this disclosure has significantly improved anti-electrochemical corrosion capability than prior techniques.

## KEYWORDS

- Electroplating
- Waterproof device
- Electrolytic corrosion
- Stack-up
- USB-C connector
- Contact pin
- Corrosion resistance

## BACKGROUND

An important feature for modern smartphones, wearable devices, and other electronic devices is the feature that such devices are waterproof or water-resistant electronic devices. During use of such devices in the presence of moisture, e.g., chemically treated water during swimming, sea water during diving, sweat from exercising, etc., there is increased exposure of the device to electrolytes. Device connectors such as USB-C connectors are thus exposed to the electrolytes, which can lead to electrolytic corrosion of the connector contact pins.

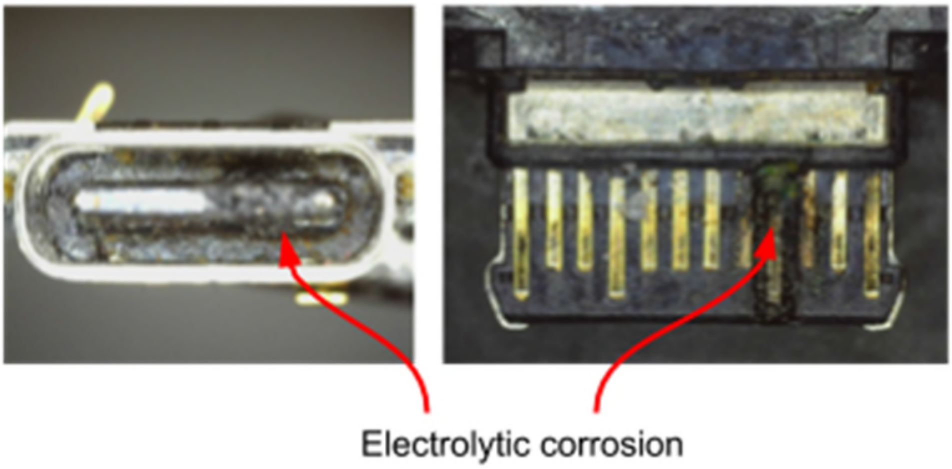


**Fig. 1: Corrosion in USB-C connectors**

Fig. 1 depicts an example of corrosion observed in a USB-C connector. The corrosion is particularly observed in pins that are utilized to transmit power, e.g., the channel configuration (CC) and $V_{BUS}$ pins. Electrolytic corrosion is triggered by a combination of the presence of electrolyte and transmission of electrical power via the pin(s). Initially, the electroplated outer layers of the pins are corroded, thereby exposing the base material of the pin, which is more susceptible to corrosion, eventually leading to complete corrosion of the entire pin. Complete corrosion of a pin can lead to charging difficulties and eventual failure of the connector in the function of delivering electrical power and signal(s).

Electroplating techniques are utilized to provide corrosion resistance. However, currently available electroplating techniques that can provide resistance to electrolytic corrosion are costly and/or include multiple and relatively thick plating layers, posing both cost and design challenges.

DESCRIPTION

This disclosure describes an electroplating configuration that is resistant to corrosion, particularly to electrolytic corrosion. The electroplating (plating) configuration can be utilized in electrical connectors, e.g. USB-C connectors, and is a stack-up of different layers and is economical in comparison to commonly available plating solutions.

Per techniques of this disclosure, the connector contact pins are electroplated in layers of copper, nickel, nickel-tungsten, gold, and rhodium-ruthenium, as shown in Fig. 2.

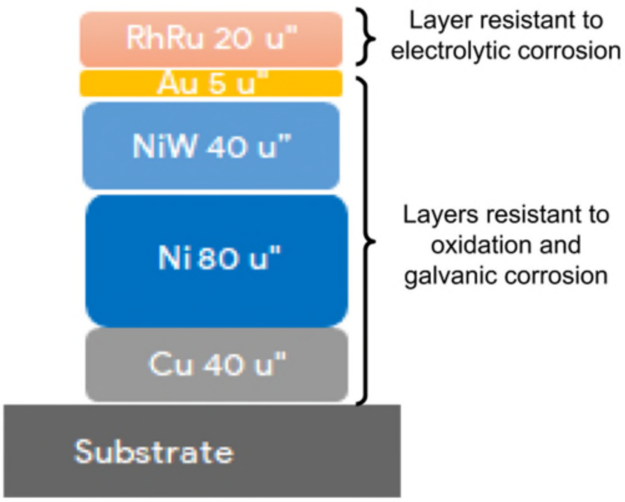


**Fig. 2: Corrosion resistant plating configuration for connector pin**

Fig. 2 illustrates an example cross-section view of a stack-up of layers of a corrosion resistant connector pin, per techniques of this disclosure. The layers include a copper (Cu) layer that is electroplated immediately surrounding the substrate, with a thickness of about 40 microinches that provides smoothening (leveling) to any roughness in the substrate. The Cu layer can be electroplated using immersion plating, after polishing the substrate electrically.

Surrounding the Cu layer are a nickel (Ni) layer with a thickness of about 80 microinches and a nickel-tungsten (NiW) layer with a thickness of about 40 microinches. The Ni and NiW layers impart improved sealing and control the pin porosity. These layers can be plated using an immersion plating process.

A 5 microinch gold (Au) layer is utilized as an interface layer between the NiW layer and an outer rhodium-ruthenium (RhRu) layer to minimize the risk of cracks due to layer hardness and stress differences between the layers. The gold layer can be electroplated using a semi-immersion electroplating process.

In order to impart electrolytic corrosion resistance, a rhodium-ruthenium (RhRu) layer with a thickness of about 20 microinches is electroplated as an outer layer, e.g., using a semi-immersion plating process. Rhodium and Ruthenium are noble metals and are resistant to electrochemical corrosion., Palladium and Platinum can also be utilized in the outer layer for added electrolytic corrosion resistance.

The electroplating stack-up described in this disclosure can withstand electrochemical corrosion for substantially longer periods than prior techniques. The stack-up provides a substantially improved corrosion resistance (by about a factor of 10) when compared to enhanced electroplating (with Ni, NiW, and Au layers) and also compared to traditional electroplating with Ni and Au layers (by about a factor of 60), at a relatively modest increase in cost.

## CONCLUSION

This disclosure describes an electroplating configuration that is resistant to electrolytic corrosion. The configuration is a stack-up of different layers that include copper (Cu) layer surrounding the substrate, a nickel (Ni) layer, and a nickel-tungsten (NiW) layer. The configuration additionally includes a gold (Au) layer utilized as an interface layer between the NiW layer and an outer rhodium-ruthenium (RhRu) layer. To impart electrolytic corrosion resistance, a rhodium-ruthenium (RhRu) layer is electroplated as an outer layer. The electroplating stack-up described in this disclosure has significantly improved anti-electrochemical corrosion capability than prior techniques.