Electroless Nickel Plating with Silver Substitute for Palladium

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Abstract

Our goal is to find a new way to produce electroless nickel plating without using palladium, which is very expensive. Instead of using palladium, we are using silver to separate nickel onto the surface of the nonconductor. Galvanic reaction is essential for the experiment.

1. Purpose

Demand for plated plastic products is increasing, and plating companies employ non-electronic nickel plating with palladium, a very expensive metal, as a catalyst. The reason why they use palladium is that it promotes oxidation of the reducing agent in deoxidizing nickel ions in an electroless nickel plating solution. Another reason is that they can reuse the solution because palladium remains in the solution after one procedure. The research of plating today, however, mainly focuses on improving binding strength between the plated material and the plating material, not on catalysts which can possibly substitute for palladium. So, at first, we looked for catalysts other than palladium. However, we could not find any substance. Next, we looked for a way to make electroless nickel plating on plastic without a catalyst.

We decided to plate nickel after we metalized the nonconductor. We found that we were able to plate on glass, while we could not plate on plastic. We think that if we stick the plating material to the nonconductor more strongly, we can make electroless nickel plating on plastic. Nowadays, most of the plating companies produce high quality plated products by using palladium as a catalyst, but palladium is much more expensive than other metals. Since palladium is so expansive, we propose that we metalize the plastic and use no catalyst. The purpose of this study was to reduce the cost of plating procedure maintaining the quality of products.

2.Materials

・petri dishes ・slide glasses ・100mL beakers ・Komagome pipets
・lead sticks ・distilled water ・1mol/L glucose solution
・1mol/L ammonic silver nitrate solution ・1mol/L sodium hydroxide solution

・Nimuden SX-M　・Nimuden SX-A (Two types of solution for electroless nickel plating which C.Uyemura&Co.,Ltd. provided for our experiments.)

<Method of experiments>

Usually, companies carry out electroless nickel plating on plastic, but such plastic is not available to us. We used slide glasses as a nonconductor.

<Conventional Method>

① Degrease
　・Do ultrasonic cleaning and alkali degreasing to the object to be plated.
② Wash
③ Etch
　・Use hydro fluoric acid or sodium hydroxide solution.
④ Wash
⑤ Sensitize
　・Use tin chloride and hydrochloric acid.
⑥ Wash
⑦ Activate
　・Use palladium chloride.
⑧ Wash and complete

<The method of experiment we propose>

① Wash
② Make background
　Mix 1mL ammoniac silver nitrate solution and 1mL glucose solution with 1mL sodium hydroxide solution. Run this liquid on the slide glasses and wait five minutes.
③ Wash
④ Make the solution for electroless nickel plating
　Mix 55mL SX-A with 100mL SX-M and add water to it until its amount reaches 1L.
⑤ Plate
　Soak slide glasses covered with silver in Nimuden heated to 90 degrees. Create Galvanic reaction by touching the slide glasses with the lead stick in the solution.
⑥ Wash and complete

3.Result

We have found that it is possible to make electroless nickel plating on a silver layer

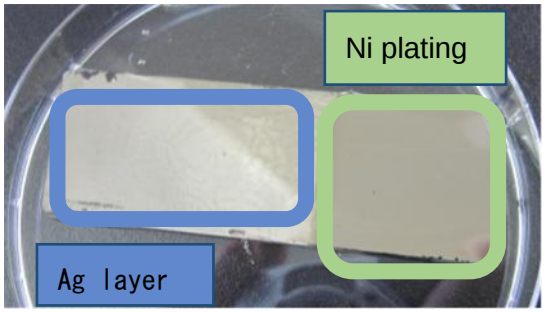
without palladium. The plating we did is illustrated in figure 1. However, we had three problems.

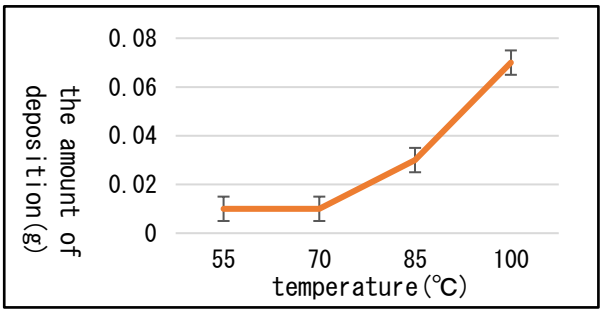
First, when we stuck a carbon stick on the silver layer, we scratched the layer and the plating peeled off. It seemed that we touched the stick to the layer very strongly.

Second, part of the silver layer peeled off when we soaked it in the nickel solution. We thought that the reason is that the adhesive power between the silver layer and the slide glass was weak. Silver had separated out on the glass, but it had not adhered strongly to the surface of the glass.

Third, it was difficult for us to control the temperature of the solution. Concretely, when the solution was boiling, its impact peeled off the plating. We had known that we can make the plating with the solution at the temperature higher than 85℃, so we tried to keep the temperature 95℃. However, the plating peeled off because the solution boiled suddenly.

The amount of deposited nickel according to the temperature is illustrated in Figure 2





the price of the metals(yen/g) ×the amount of layers(g/cm²) × $\frac{1.0\times10^{4}(\mathrm{cm}^2)}{1.0(\mathrm{m}^2)}$

= the price per 1m^2(円/m²)

layer	The price of the metal (yen/g)	the amount of layers (g/cm²)	the price per 1m² (yen/m²)
palladium	3741	4.0×10^{-6}	149.64
silver	65	1.0×10^{-4}	65

Out of the merits we found in this experiment was that we could reduce the cost of metal we used for plating. We omitted the cost of electricity we used for the experiment to calculate the whole cost. The difference between the previous method and ours is whether we use palladium or silver. So, we only compared the cost of making one square meter of electroless nickel plating. Our calculation is in Figure 3. List 1 shows the numerical value of our calculation and its result.

The price of the metal is equal to the average retail price from April 9 2017 to April 20 2017.

If we use silver instead of palladium, we can reduce the cost of the procedure by 57%.

4.Evaluations and Problems

Our nickel layer didn't cover the glass perfectly because the lead stick made scratches between the glass and silver. So we suggest using the lead powder instead of a stick. After putting the lead powder on the glass, we soak it in the nickel solution. In this way, we can start a galvanic reaction.

And we had another issue. There was weakness in the adhesive strength because we didn't do etching. If we do etching, the plating will not peel off easily.

We didn't do our experiments with plastic, but we can suppose that plastic plating with nickel, without palladium is also possible, if we apply our new ways in which we use silver instead of palladium.

5. References

① Adhesion of Electroless Nickel Plating on Glass
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② Initial Deposition Behavior of Electroless Nickel on Glass Substrate
Seiji YAMAMOTO Katsuhiko TASHIRO and Hideo HOMMA

③ Plating Technology on Plastics for Automobile Parts
Katushi HIDAKA*

6. Key words

Non-electronic Nickel Plating Silver Palladium