Development of Coating Materials of High Conductivity Ag layer for Electroplating Technologies

Satoru Hashimoto[1], Teruyoshi O. Hirano[2]
[1] HYOUKAKEN Co., Ltd., 1-8-4, Sakumacyou, Chiyoda-ku, Tokyo 101-0025, Japan.
[2] GGK Co.,Ltd., 2-8-1, Nishi-Shinbashi, Minato-ku, Tokyo 105-0003, Japan.

INTRODUCTION

Nickel and/or Copper plated plastic materials are being used a lot in industrial and home use. Plating layer is added plastic molded items new functions protect against oxidization and scratch. In general, the plastic plating by electroplating is performed after the grant of a conductive substrate coating. The condition of this substrate coating has been known to significantly affect the plastic plating adhesion and durability. For example, the condition of the substrate coating is not good, its plating layer would have been easy to peel. In addition, more than half of the plastic plating process is a surface treatment as substrate coating, which increases the cost factor of Ni and/or Copper plating.

We have developed a Silver mirror coating technology. Our Silver mirror coating, which has excellent gloss and high durability. In last year's MRS 2011 spring meeting, we reported the development of the treatment materials to improve the durability of thin Silver mirror coating film. The new Improved materials supply high durability and strong adhesion to molding items.

In this paper, we propose to use a thin electro-conducting film prepared with Silver mirror coating technology for plastics plating. We have a new plastic plating process with a Silver mirror layer. We tried to apply this technology to the base coating layer for plastic plating. The new process uses a thin plating of Silver reported in this paper, which can significantly shorten the plating process. Therefore, the new processes allow a very large cost savings and reduce environmental impact.

EXPERIMENT

We prepared the conductive base layer with Silver mirror coating technology to be used by Copper plating.

A) Silver mirror coating technology

The Silver mirror coating technology[1)] is a typical Silver thin film formation technology. Silver mirror coating technology has been used commercially for decorative paint an. The Silver thin film that formed by a Silver mirror coating technology has the large conductivity. We can apply the Silver layer to a plating base.

Figure 1 shows a configuration of a decorative Silver layer formed by the normal processing of Silver mirror coating. 1st step of the Silver mirror coting is to prepare the base coating. 2nd step of the coating is forming of the Silver layer. 3rd step of the coating is forming protective top coating.

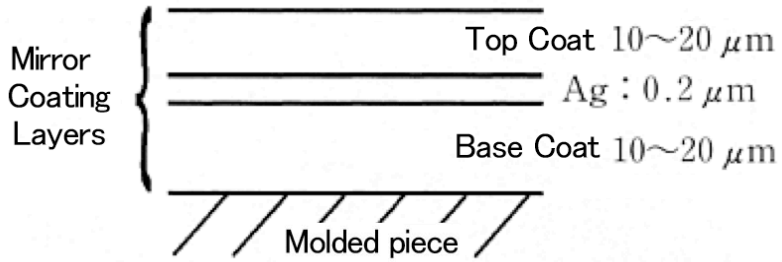


Figure 1 Structure of layer system of decorative the Silver mirror coating.

Figure 2 shows to explain the process of Silver thin layer formation with the Silver mirror coating. As shown in the figure 2, it is possible to form a thin film layer of Silver in a manner similar to spray painting process. Figure 3 shows a reduction reaction of Silver being generated at this time.

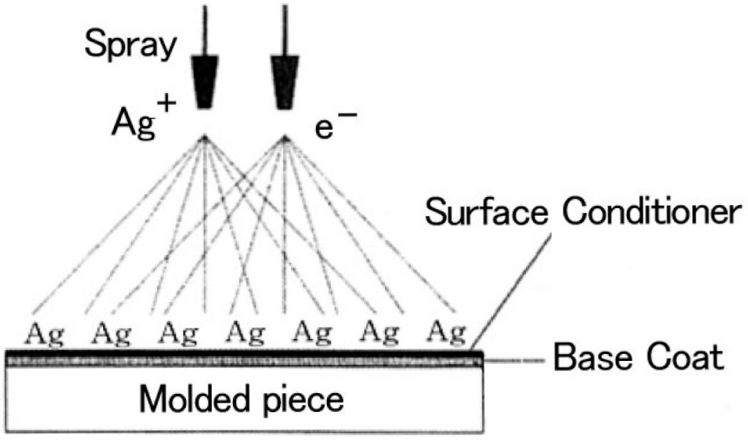


Figure 2 The spray coating mechanism for the Silver layer.

$$R + H_2O \rightarrow RO + 2H^+ + 2e^- \quad (1)$$

$$Ag^+ + e^- \rightarrow Ag \quad (2)$$

Figure 3 Chemical equation of the mirror reaction.

B) Silver layer used as a plating base coating

Figure 4 shows a typical Nickel and/or Copper plating processes to plastic item. The left side of the figure 4 is a conventional process of a plating process to plastic item. The right side of the figure 4 is the new process that is reported our paper. The new process with the Silver mirror coating technology can replace ordinary processes of surface preparation for electroplating. In the process shown in this paper, it is significant shortening of the electroplating process becomes provably half is expected to be traditional.

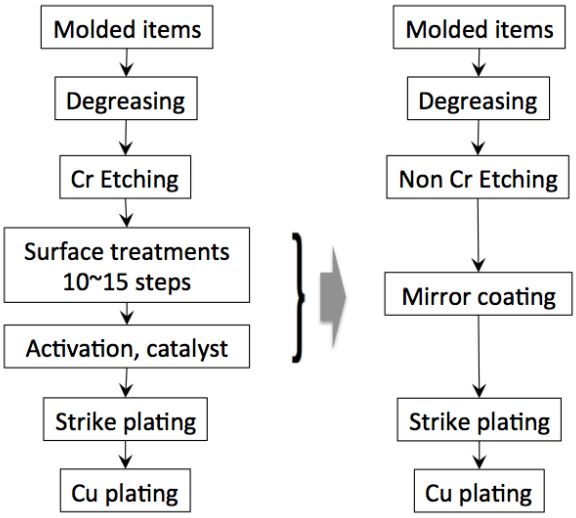


Figure 4 Plating processes for plastic item. left: ordinary process, right: proposed process.

Figure 5 shows the layer structure of the Copper plating process can be obtained by utilizing the Silver mirror coating proposed in this paper.

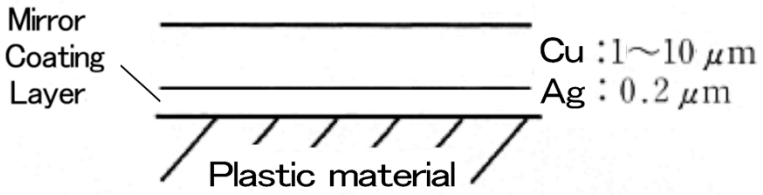


Figure 5 The stack structure of the Copper plated with the Silver mirror layer.

C) Preparation of Copper plating with the Silver mirror layer

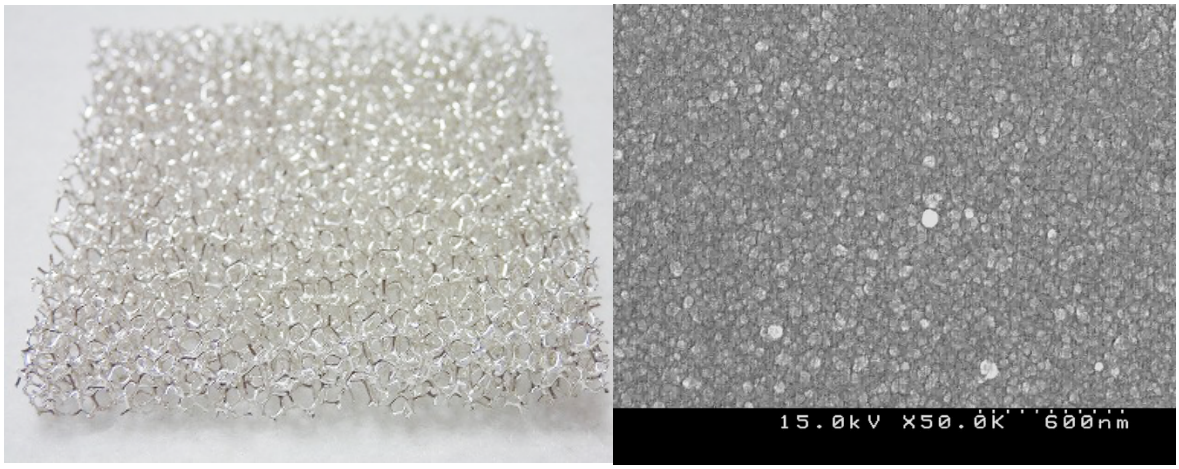
We carried out trial Copper electroplating using molding items those made by several kinds of plastics. In the first trial, after the etching process for general molding ABS (Acrylonitrile / Butadiene / Styrene), we coated Silver thin layer, then electroplating was carried out. The thicknesses of the Copper electroplating layers were prepared from 1μm to 10μm by electroplating processing time. In the second trial, we used molding urethane items as base materials. In the third trial, we used acrylic molding items as base materials. In both trials, the Silver mirror coating was carried out. Then the thicknesses of the Copper electroplating layers were controlled with processing time.

DISCUSSION

A) Characteristics of the Silver mirror coating

Figure 6 show that the image (a) of Silver mirror coated item and the surface observation image (b) with an electron microscope. The base Silver layer that coated the Silver mirror coating technology was excellent condition. The thickness of the Silver thin layer was about 200 nm. The Silver coating processing time was about 60 seconds. Electrical resistance of the Silver

layer is about 1 Ω/cm^2 approximately (under 1 Ω/cm^2). The base film, it was confirmed that the Silver thin layer was consecutive, can be used as a conductive layer of plating base. Therefore, we use as a base layer of the Silver thin film for Copper electroplating.



(a) photo image (b) SEM image

Figure 6 The images of the Silver layer.

B) Copper plating to ABS molding items

In prototype plating tests were carried out. For 1st test, we selected ABS molding material that is very generic. In figure 7, we show the samples of Copper plating items with the Silver mirror layer. The condition of surface is so excellent almost like ordinary plating processes. The Copper plating shows high gloss looks like a mirror. And the samples show good results of anti-peel test.

Figure 7 The Copper plated samples were fabricated using a substrate ABS.

Figure 8 shows the photo image of Copper plating item that used for adhesion tests. The peel test was performed with cross-cut samples. As shown in figure 8, the test sample shows the good adhesion characteristics. The adhesion property of the test sample is same extent as Copper plating via a conventional process.

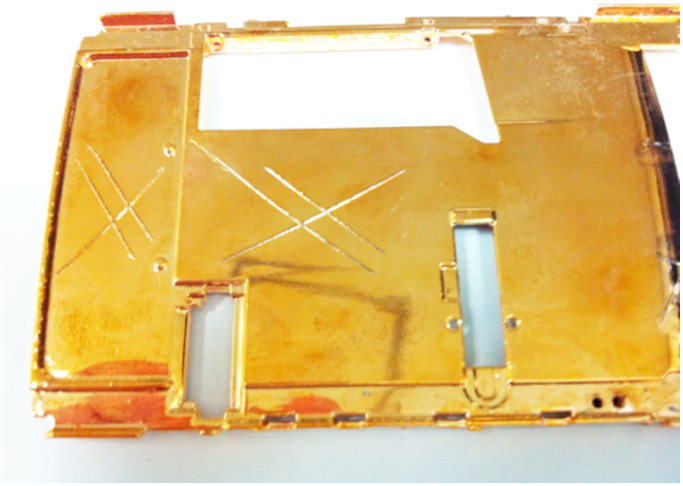
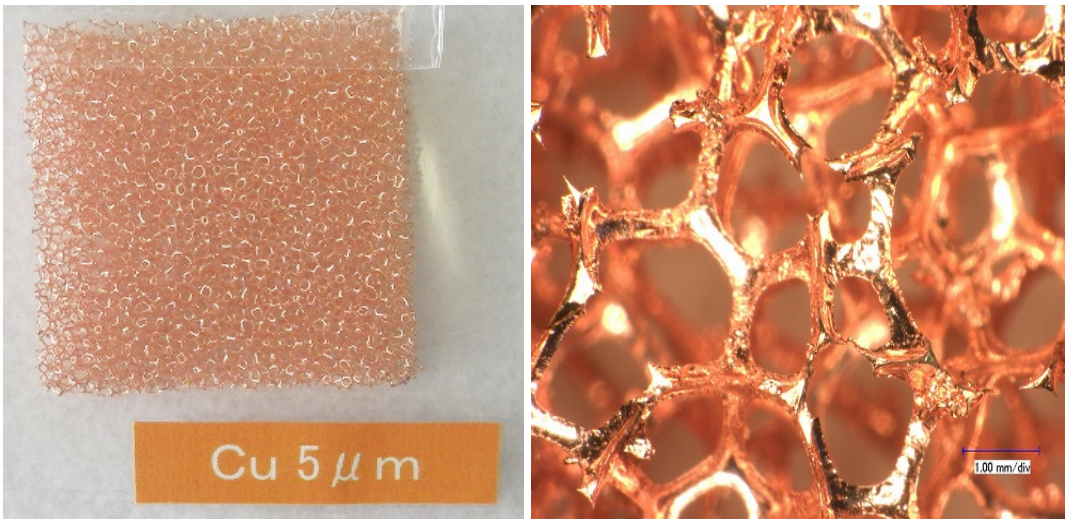


Figure 8 The result of cross-cut peel test.

C) Copper plating to urethane molding items

Figure 9 indicate images of Copper plating samples made by urethane. In figure 9, we show the (a) which is photograph of the item, (b) is a magnified surface image. The thickness of the plated Copper layer is about 5μm. Surface of the Copper plating is good, that shows the high gloss.

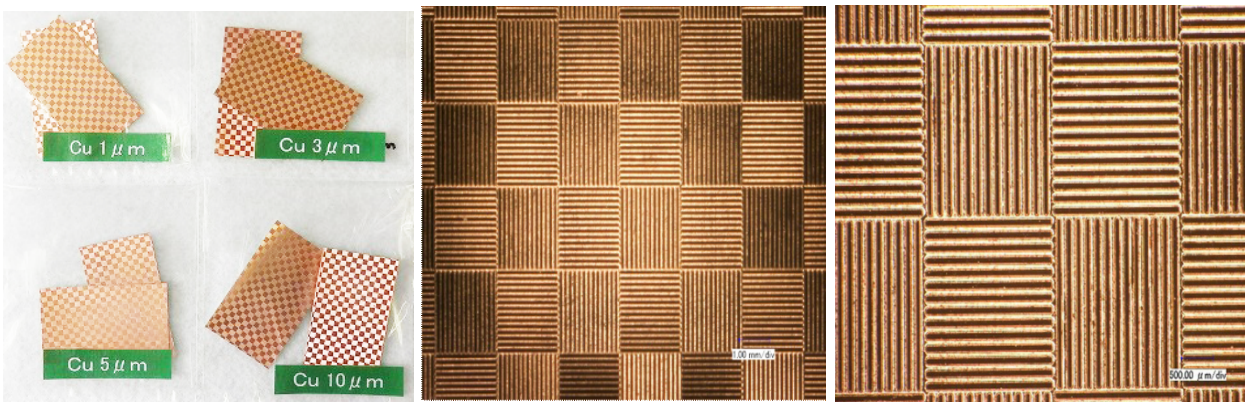


(a) (b)

Figure 9 Copper plated sample was fabricated using a urethane base material.

D) Copper plating to acryl molding items

Figure 10 show images of Copper plating samples made by acryl material. The acrylic material used in the prototype, with the irregularities of the shape of the stripe width 100μm. The image of (a) is a photo of the entire samples. The image (b) is a photo of the Copper plated sample. In addition, image (c) is a magnified image. The surface state of Copper layer is good, that shows the high gloss.



(a) samples (Copper:1~10μm) (b) Copper plating item (c) magnified image

Figure 10 Copper plating samples fabricated with acryl material.

CONCLUSIONS

We have reported the material of Silver mirror coating was optimized using the new plastic plating process. The proposed process using the Silver thin film layer prepared with the Silver mirror coating technology. The Silver mirror coating technology has been improved dramatically and able to apply decorative painting. The current Silver layer prepared with Silver mirror coating has high durability. It is enough for industrial use for painting and plating. As a result, it was confirmed that the plastic material of the species could be for 3 ABS, urethane, acrylic, Copper plating to form a good film.

New plating process using the Silver thin layer is reported in this paper, to enable significant reduction of the plating process. In the new proposed plating process of Copper to plastic item with Silver mirror layer, to allow a very large cost reduction and environmental load reduction. Is the possibility of industrial applications with low environmental impact, as the new technology of plastic plating.

REFERENCES

1. S. Hashimoto, T. Hirano, TOSOUGIJYUTSU, **45**(2), 46 (2006).