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pH Effects of Electroless Ni Plating on ABS Plastics

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Metal plated plastics are becoming more prevalent in materials of communication parts. A new technique MmSH is a process of injecting plastics to produce innovated physical properties compared to the conventional injection process. This study involves two ways of coating plastics Ni by electroless plating and varying bath and plasma treatment for improved adhesion strength between plating layer and surface. MmSH injection processed ABS with plasma treated after neutralization showed a superior adhesion force and a gloss and rate of deposition when it was in pH 7.5. On the other hand, conventional injection processed ABS was in pH 6.5.

Keywords *: electroless Ni plating, ABS plastics, pH, plasma treatment.*

1. Introduction

Electroless plating is a plating technique without using electricity. Instead of electricity a reducing agent is used to supply electrons to the metallic cations. It has many advantages such as uniform plating thickness on complex parts and plating on non-conductive materials like plastics.[1] And it has been announced that electroless plating has effect of electromagnetic interference(EMI) shielding. Thus, electroless plating techniques of Cu, Ni are required by electric equipment parts because of these advantages.[2]

Almost all covers of electric equipment have been made of ABS plastics that have excellent physical properties such as light weight, malleability, and low cost, etc. So, electroless plating on plastics is necessary according to this tendency. Conventional injection processed plastics have some limiting surface defects like weld line, flow and gas mark, etc. On the other hand, injected ABS by MmSH*[3] (momentary mold surface heating) technique has no surface defects and low cost compared to the conventional injection process. However, it has not been studied for plating.

This experiment examined various conditions for electroless Ni plating on both conventional and MmSH injected ABS by changing pH in a bath. Gloss, thickness, and adhesion strength by plasma treatments on the plastic surfaces were studied.

2. Experiment

2.1 Injection of ABS

ABS(Acrylonitrile Butadiene Styrene) plastics were used as a substrate. ABS was made by Cheil industries INC, Starex, grade No : EG-0763D. It matched to A : B : S = 23 : 16 : 61. Two injection processes, conventional process and MmSH, were employed in this study. The injection conditions are shown in Table 1.

Table 1. Injection conditions of conventional process & MmSH.

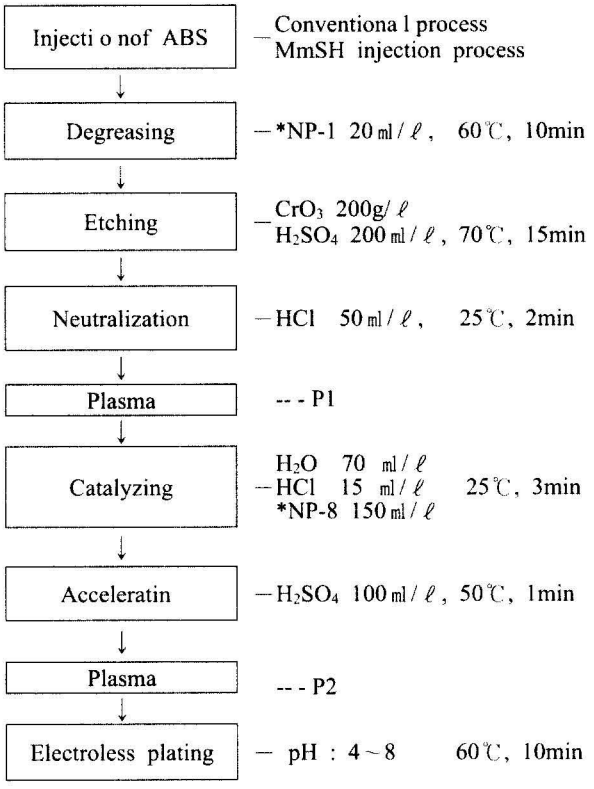
	IF5←	IF4←	IF3←	IF2←	IF1←So
distance (mm)	0~5	5~11	11~25	25~30	30~36
pressure (kg/㎠)	86(67)	90(72)	90(72)	89(70)	80(65)
velocity (%)	62(54)	67(58)	67(58)	65(56)	58(50)
hold pressure (kg/㎠)	10	11	20	35	55
(sec)	0	0	0	0	4.5

- Injection pressure : 55 kg/㎠
- Mold temperature : 70℃
- Injection time : 2.3 sec
- Air pressure : 5 kg/㎠
- Cooling time : 15,(20)sec

IF ~ So : Past position in Mold
( ) : Injection condition of MmSH

2.2 The process of preparation and electroless Ni plating

Fig 1. shows the process and compositions of preparation for plating. As shown in Fig 1, the plasma producing process was employed in either P1 stage or P2 stage. Plasma treatment speed was 0.004m/s, 6 times in He gas. Before proceeding to the next process, the specimen was thoroughly cleaned by distilled water for 2 minutes.



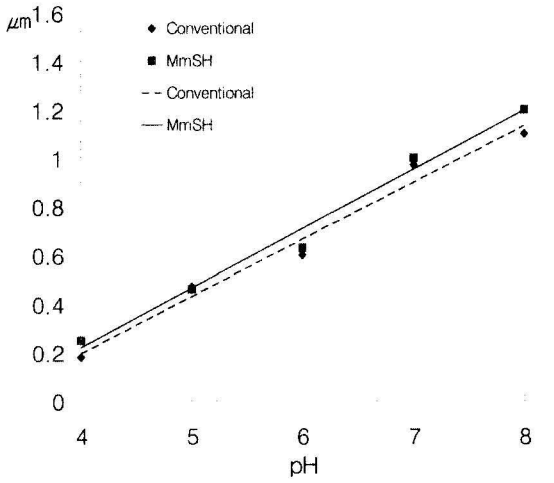
* NP-1, NP-8 : Trade name of KPM tech
P1, P2 : Plasma treatment

Fig. 1. Process diagram of Electroless Ni plating.[4]

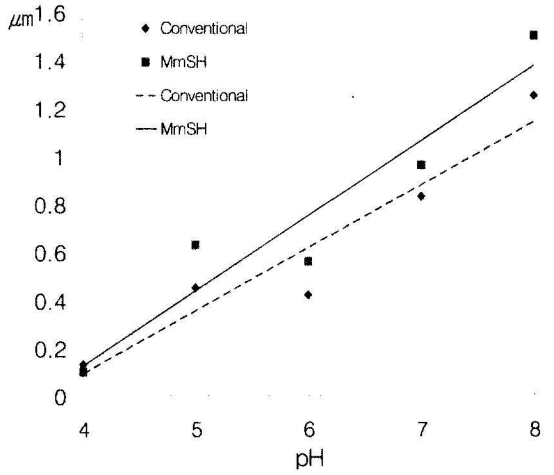
The composition of the electroless Ni plating bath is shown in Table 2. Sodium hypophosphite was used as a reducing agent. The pH range was 4~8 with an interval of 0.5, which are adjusted by 10% NaOH or 10% HCl.

Table 2. Compositions of electroles s Ni plating bath.[5]

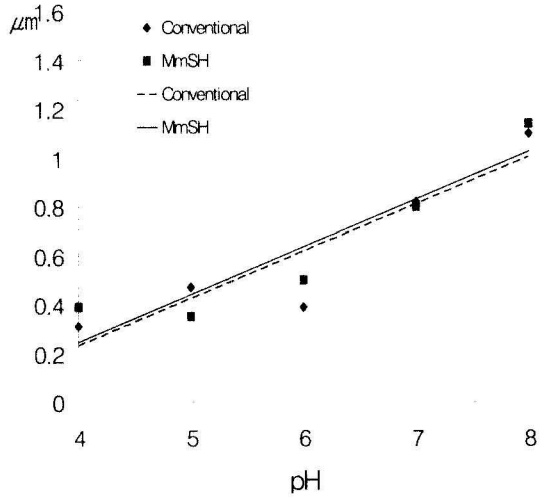
Nickel sulfate	$NiSO_4$-$6H_2O$	29 g/ℓ
Reducing agent	NaH_2PO_2-H_2O	25 g/ℓ
Complexing agent	$C_6H_7O_8$	15 g/ℓ
Accelerator	CH_3COONa	5 g/ℓ
Stabilizer	$PbNO_3$	2 ppm



a) Electroless Ni plating



b) Plasma treatment after acceleratin



c) Plasma treatment after neutralization

Fig. 2. Measurements of plating thickness vs. bath pH.

2.3 Measurements and test

Thickness and gloss of Ni plating were measured by an X-ray fluorescent thickness tester XRF-2000, Micro pioneer Co. and a gloss meter VGS 300A, Nippon Denshoku Industries Co. with 60° angle of measurement, respectively. Adhesion tests were performed according to ASTM D3359[6] with cross hatch cutter(part No.F10913222) and adhesive tape(part No.T1078894) has a force 6N/25 mm, Elcometer Co.

3. Results and Discussions

3.1 Plating thickness

Fig 2. shows plating thickness as a function of pH conditions. The thickness increased as pH increased in all the tested conditions up to pH 8. Generally, electroless Ni plating is known to have increased reduction rate as bath pH is increased in an acidic solution.[1),7)] This study observed that, with the same tendency as an acidic solution, coating thickness was increased in alkali solution (pH7 ~ 8), as shown in Fig 2. It was hypothesized that plating thickness will increase above pH 8. However it more experiments need to be performed in this region above pH 8.

3.2 Gloss

Fig 3. shows gloss that from plasma treatment after neutralization(P1) was better than plasma treatment after accelerating(P2) in both MmSH and conventional injected ABS. MmSH injected ABS had excellent gloss compared to conventional injected ABS. In the case of plasma treated ABS after neutralization(P1), a superior gloss appeared, compared to (P2) except at pH 6. Before experimentation, it was originally believed that this condition would have good gloss like pH 5.5 and 6.5. However, treatment may not have been prepared very well, resulting in a lower gloss compared to other conditions.

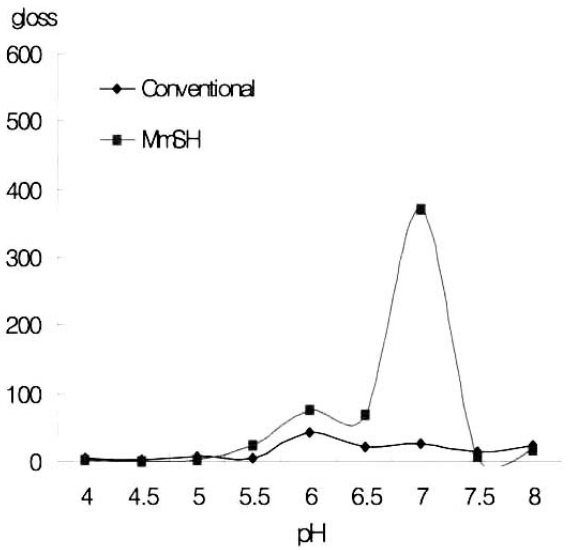
3.3 Adhesion strength.

Plasma treated ABS after neutralization(P1) had a distinguished adhesion force compared to the other condition(P2). MmSH injection processed ABS showed a tendency for good adhesion strength compared to conventional injection processed ABS. It is hypothesized that plasma treatment(P1) cleans the plastic surface, and helps the Pd-Sn catalyst adhere, thus improving adhesion strength.

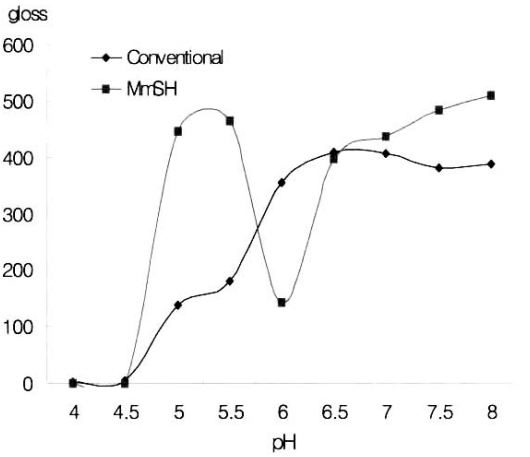
Table 3. Tape tests of adhesion strength.

pH	Non-plasma		P2		P1	
	C	M	C	M	C	M
4	2B	2B	4B	4B	4B	5B
4.5			4B	4B	5B	5B
5	4B	4B	4B	4B	5B	4B
5.5			4B	4B	5B	5B
6	4B	5B	4B	4B	5B	5B
6.5			4B	4B	5B	5B
7	4B	5B	4B	4B	4B	4B
7.5			4B	4B	4B	5B
8	4B	5B	4B	4B	4B	4B

P2 : After acceleratin g plasma treatment
P1 : After neutralizat i o rplasma treatment
C : conventional injected ABS
M : MmSH injected ABS



a) Plasma treatment after accelerating.



b) Plasma treatment after neutralizati on.

Fig. 3. Surfac e gloss of Ni plating vs. pH graph

4. Conclusion

1. In all of the processes, thickness appeared to be directly proportional to pH.

2. Electroless Ni plated on ABS plasma treatment after neutralization(P1) have excellent gloss and adhesion strength compared to other conditions.

3. MmSH injection processed ABS showed a superior gloss and adhesion force when it was in pH 7.5, while conventional injection processed ABS was optimal in pH 6.5.

References

1. T. K. Ji and W. Y. Yeo, *J. Korea Ins. of. Sur. Eng.*, **15**, 1 (1982).
2. H. K. Kim, Technology the Tendency of Electroless Plating, *J. Korea Ins. of Ind. and Tec. Info.*, (1994).
3. Patent of NADA Innovation Co. Ltd.., Korea - 1998-0705390, U.S. - 6544024B1, Taiwan - 166877
4. H. T. Yum and J. S. Lee, "Metal · Surface treatment", 277, 2002.
5. Y. S. Park, M. H. Lee, J. M. Ahn, and T. H. Kim, *J. Korea. Ins. of. Sur. Eng.*, **33**, 447 (2000).
6. ASTM D 3359-95, Standard Test Methods for Measuring Adhesion by Tape Test, 350. (1995).
7. S. J. Jung, H. S. Choi, J. E. Park, S. G. Park, and J. S. Lee, *J. Korea Electric & Electron Material Soc.*, 625 (1999).