CHAPTER V

EXPERIMENTAL RESULT

Effect of Etching Solution

1. ABS plastic was subjected to some organic solvents such as diethyl ether, acetone, methyl alcohol and their mixtures. It was found that ABS plastic specimens tended to dissolve in these solvents resulting in rough and sticky surface not suitable for the following electroless deposition. Hence neither copper nor nickel electroless plating were performed after using organic solvents etching solutions. The organic solvents used and their effects are shown in Table 5-1.

2. The results of the experiments performed by varying the amount of chromic acid and sulphuric acid in the etching solutions, are shown in Table 5-2. This indicated that etching solution composition No.1 to 4 (see Table 4-1 for the compositions) could produce microroughness on the plastic surface, thence either nickel or copper from nickel or copper electroless solution could be deposited on the plastic surface. For etching composition No.5, ABS plastic tended to dissolve at this composition, so further electroless

deposition was not performed.

Table 5-1 Effect of organic etching solution

Organic Solvent	Plastic Surface Characteristic
diethyl ether	dissolve
acetone	dissolve
methyle alcohol	dissolve
50% v/v diethyl ether 50% acetone	dissolve
50% v/v acetone 50% methyl alcohol	dissolve
50% v/v diethyl ether 50% methyl alcohol	dissolve

Table 5-2 Effect of etching solution

Etching No.	Copper Deposition	Nickel Deposition
1	yes	yes
2	yes	yes
3	yes	yes
4	yes	yes
5	no	no

Effect of Activating Solution

By using palladium activating solution, an unnoticeable palladium metal was deposited to form nuclei on the plastic surface. Copper or nickel could be further deposited on this surface by treating in the copper or nickel electroless solution.

For silver activating solution, a dark film of silver became visible on the plastic surface. This film was thick enough to conduct electric current. Copper electroplating could be performed directly on this surface after such activating step.

Effect of Electroless Plating Solution

Either copper or nickel layer was formed on the activated plastic surface after treating in copper or nickel electroless plating solution. The characteristics, such as color, appearance, and surface smoothness are shown in Table 5-3 .

Table 5-3 Characteristic of plastic surface after electroless plating

Etching No.	Activating solution	Electroless solution	Surface characteristic		
			color	appearance	surface smoothnees
1 - 4	palladium	copper	red	dull	good
1 - 4	palladium	nickel(acid)	grey	dull	good
1 - 4	palladium	nickel(alk.)	grey	dull	good
1 - 4	silver	--	grey	dull	good

The Characteristics of Electroplating on Plastic

After the electroless plating step, plastic surface was covered with thin metal layer which was thick enough to be followed by electroplating. The characteristics of the specimens after each electroplating : color, appearance and surface smoothness are shown in Table 5-4 .

Table 5-4 The characteristics of the specimens after electroplating

Electroplating	Surface characteristic		
	color	appearance	surface smoothness
bright copper	red	bright	good
semibright nickel	white	semibright	good
bright nickel	white	lustrous	good
chromium	bluish -white	brilliant	good

Peel Strength

Adhesion of the metal plate to the substrate was evaluated by peeling a one-inch wide strip of finish coating from the substrate in a peel strength tester and recording the force needed to separate the metal coating from the substrate. Table 5-5 gives the values of peel strength measurements obtained by using ABS plastic as substrate. Fig. 5-1 to 5-4 and Table 5-5 show the effect of various etching compositions on adhesion strength.

There are two types of failure; in the case of low peel strength values (1.5 to 1.9 lb/in), the metal coating separates clearly from the plastic while the high peel strength data (1.9 to 2.4 lb/in) represent the cases where the coating is ripped and the residues of the coating remain on the substrate.

Corrosion Resistant of Plated Plastic

Blister develop when metal is plated on plastic substrates and subjected to corrosive environments (CASS Test). Neither rust nor scale took place after testing in this severe condition. Qualitative comparison of corrosion resistant of chromium plating on the same substrate (ABS plastic) under difference plating conditions is shown in Table 5-6.

Interlayer Structure Between Plastic and Metal Coating

The mechanical property described as "adhesion" is difficult to measure. In this experiment, the interphase layer between plastic and metal, investigated under a reflecting microscope (Fig.5.5 to Fig.5.20) showed roughness as a result from the oxidising and etching of the plastic surface. This will aid the metal to penetrate through the roughness and performs as mechanical keying apart from the chemical keying from the organo-tin formation. However, it does not show any significant difference since the ordinary reflecting microscope is not sophisticate enough for such investigation.

Table 5-5 Peel strength testing

Run No.	Peel Strength lb/in				Average peel strength lb/in
1A	1.85	1.90	2.00	1.79	1.89
2A	2.06	2.16	2.08	1.97	2.07
3A	2.16	2.35	2.30	2.15	2.24
4A	2.05	2.00	1.98	1.94	1.99
1A	1.67	1.70	1.72	1.76	1.71
2B	2.20	2.33	2.16	2.35	2.26
3B	2.19	2.36	2.49	2.46	2.38
4B	2.00	2.05	1.95	1.86	1.97
1C	1.59	1.49	1.62	1.56	1.57
2C	1.65	1.80	2.02	2.06	1.88
3C	2.30	2.32	2.29	2.30	2.30
4C	1.95	1.99	2.02	2.00	1.99
1D	1.60	1.42	1.52	1.49	1.51
2D	1.88	1.95	1.91	1.87	1.90
3D	2.23	2.31	2.15	2.20	2.22
4D	1.51	1.58	1.63	1.68	1.60

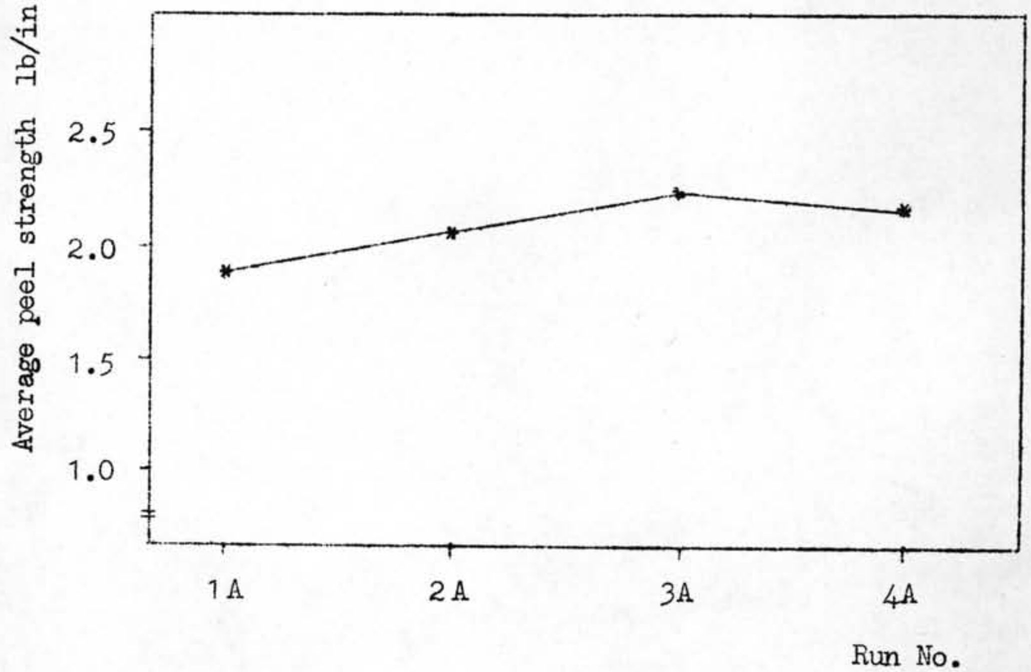


Fig.5-1 Effect of etching composition on adhesion strength

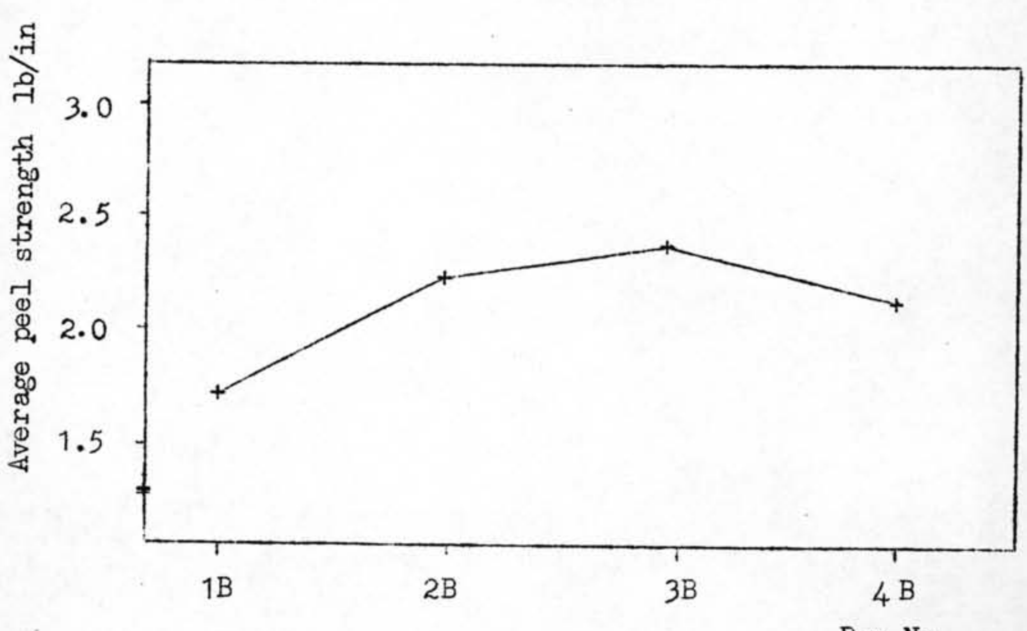


Fig.5-2 Effect of etching composition on adhesion strength

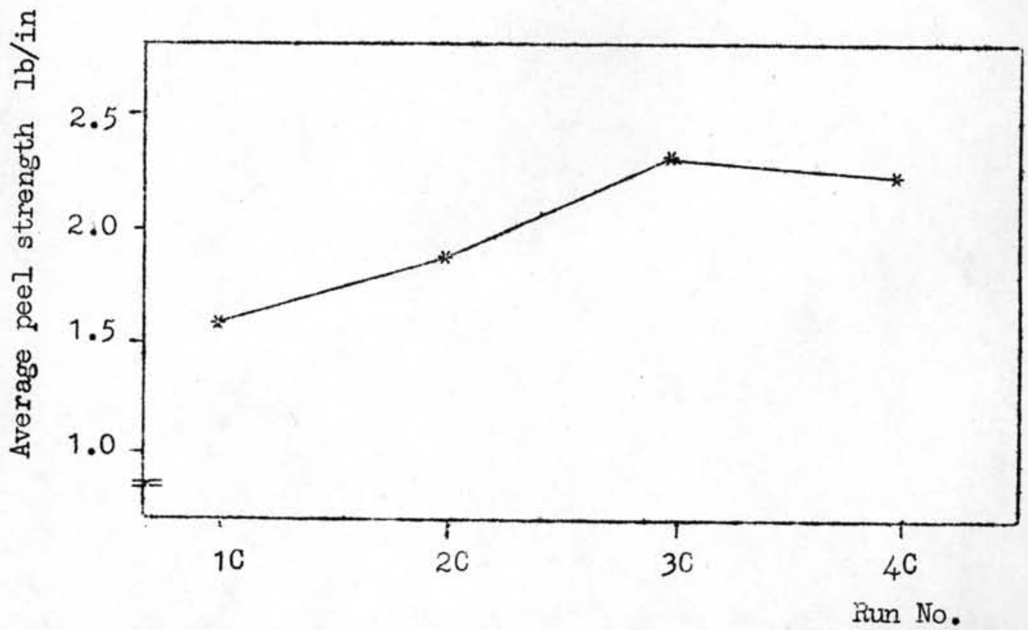


Fig.5-3 Effect of etching composition on adhesion strength

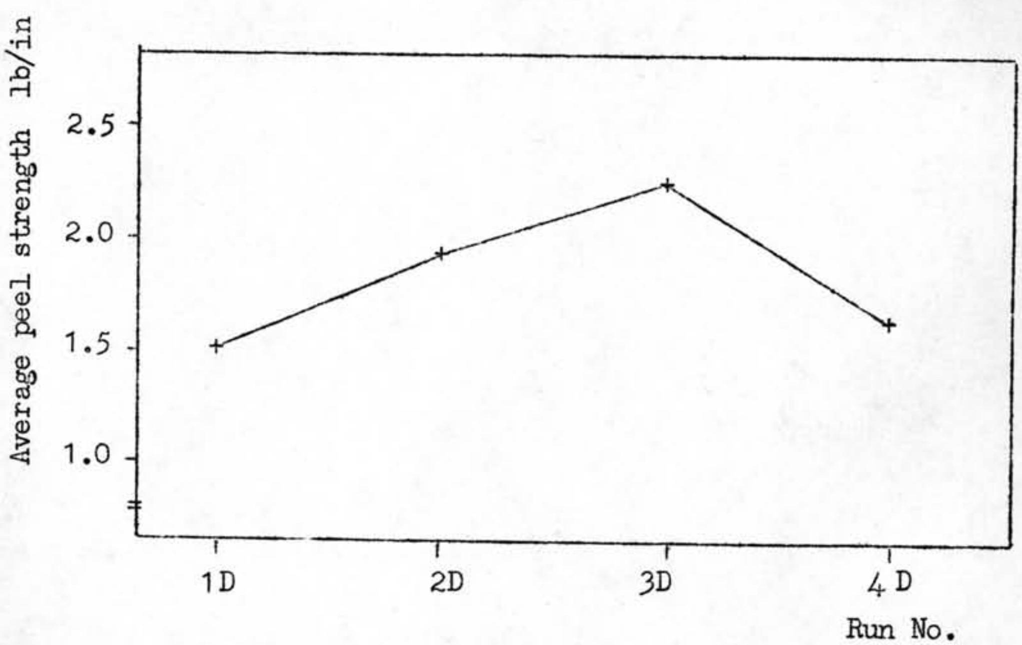


Fig.5-4 Effect of etching composition on adhesion strength

Table 5-6 Corrosion resistant of plated plastics

Run No.	Corrosion Resistant (CASS Test)
1A	poor
2A	poor
3A	good
4A	poor
1B	good
2B	good
3B	good
4B	good
1C	fair
2C	good
3C	poor
4C	good
1D	poor
2D	good
3D	good
4D	fair

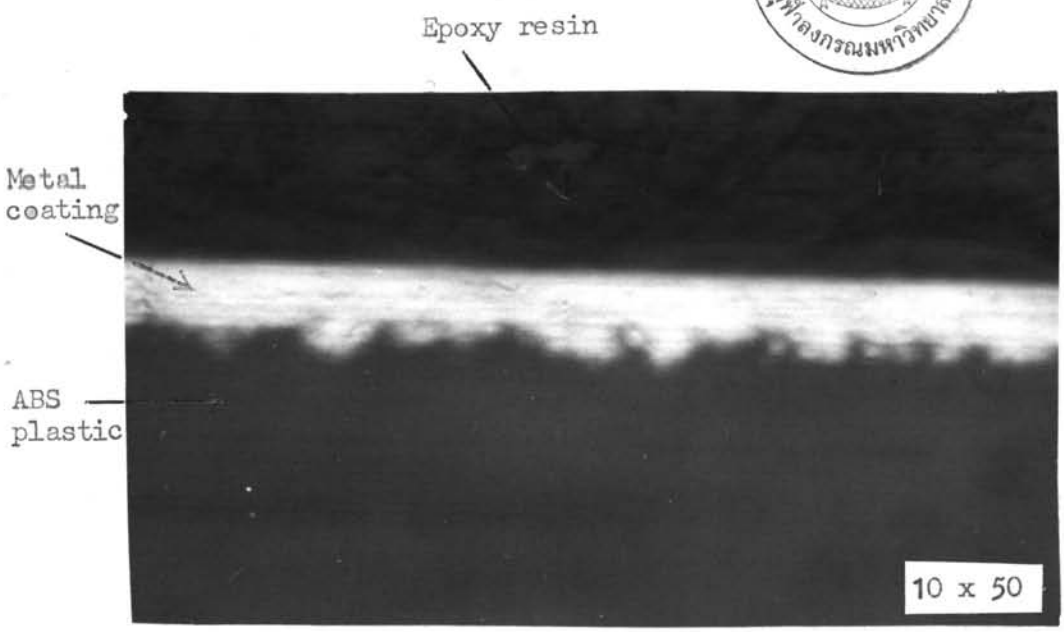


Fig. 5-5 Interlayer structure between ABS plastic and metal coating of specimen run No. 1A

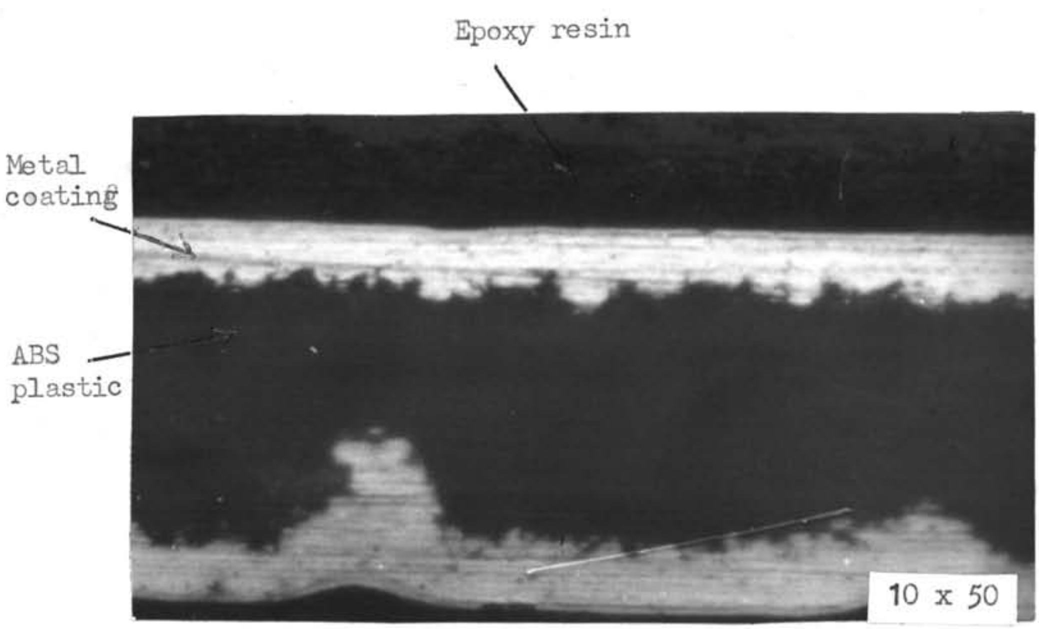


Fig. 5-6 Interlayer structure between ABS plastic and metal coating of specimen run No. 2A

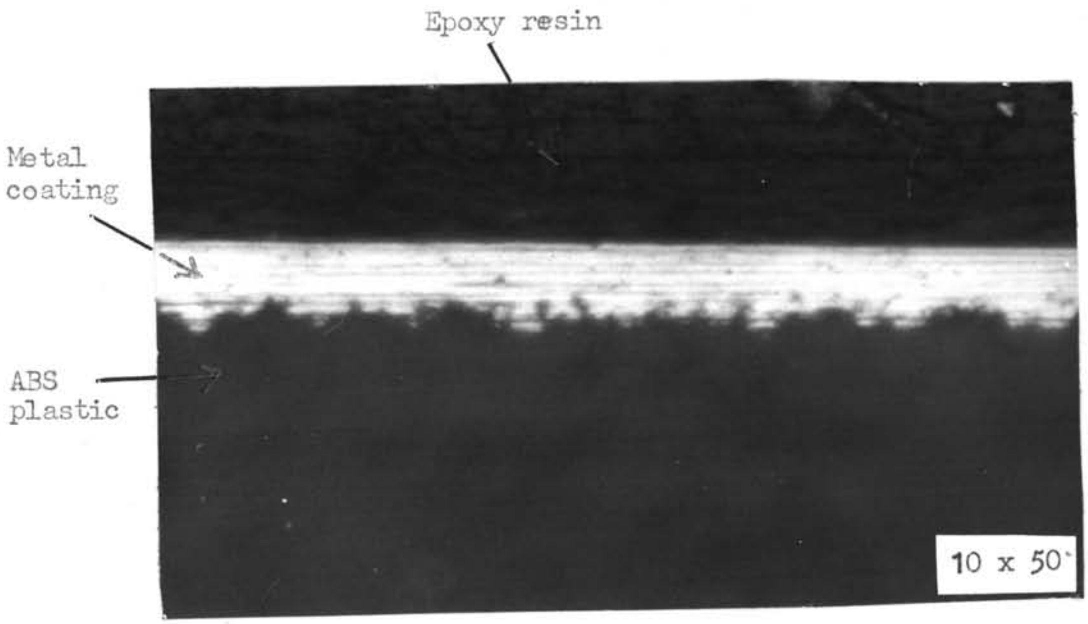


Fig. 5-7 Interlayer structure between ABS plastic and metal coating of specimen run No. 3A

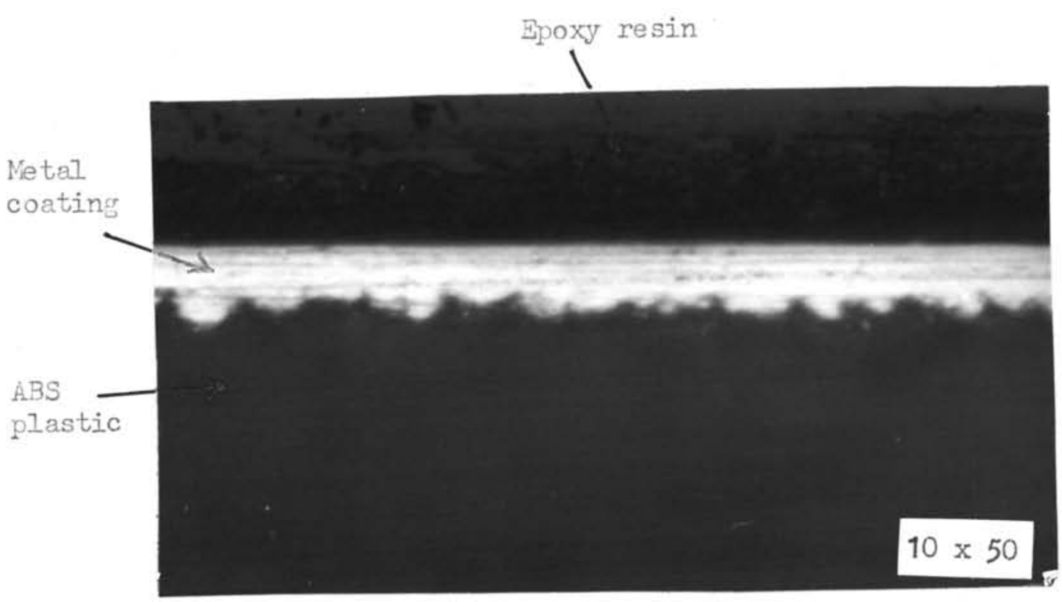


Fig. 5-8 Interlayer structure between ABS plastic and metal coating of specimen run No. 4A

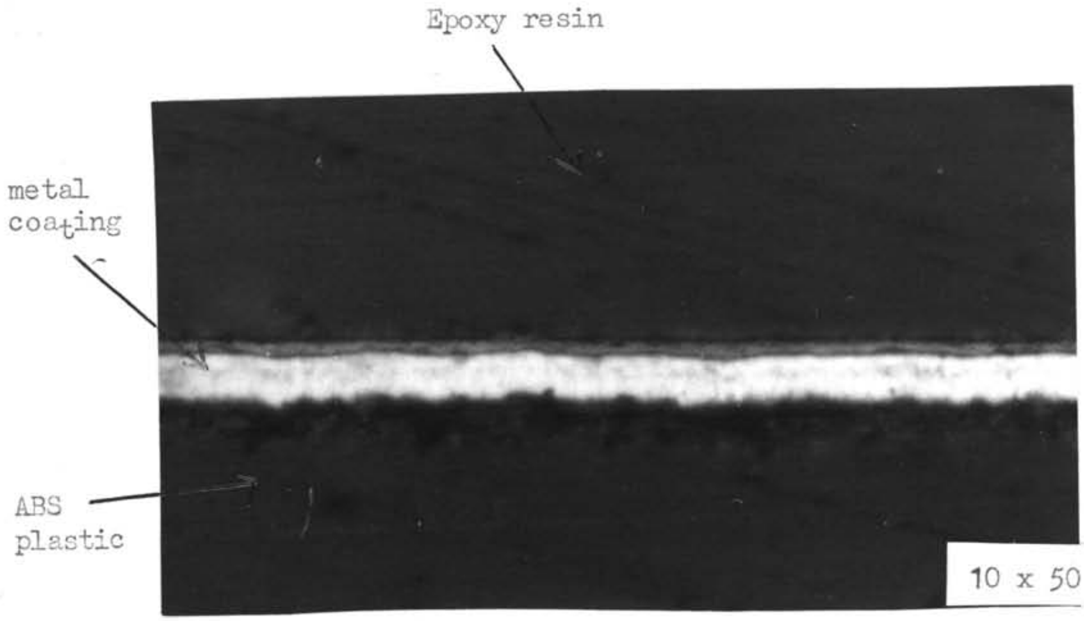


Fig. 5-9 Interlayer structure between ABS plastic and metal coating of specimen run No. 1B

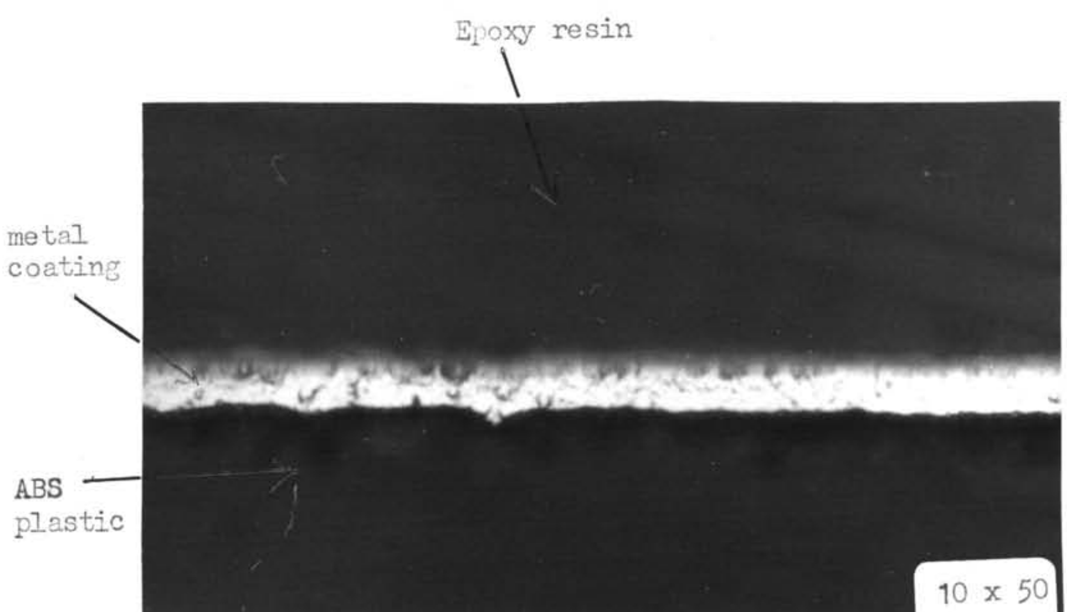


Fig. 5-10 Interlayer structure between ABS plastic and metal coating of specimen run No. 2B

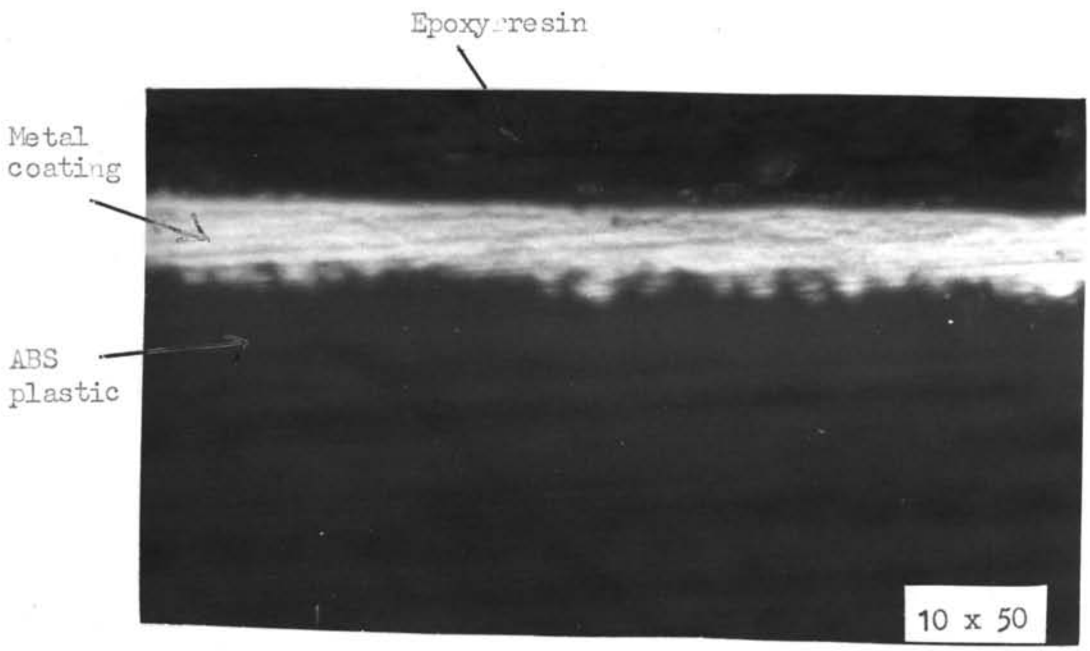
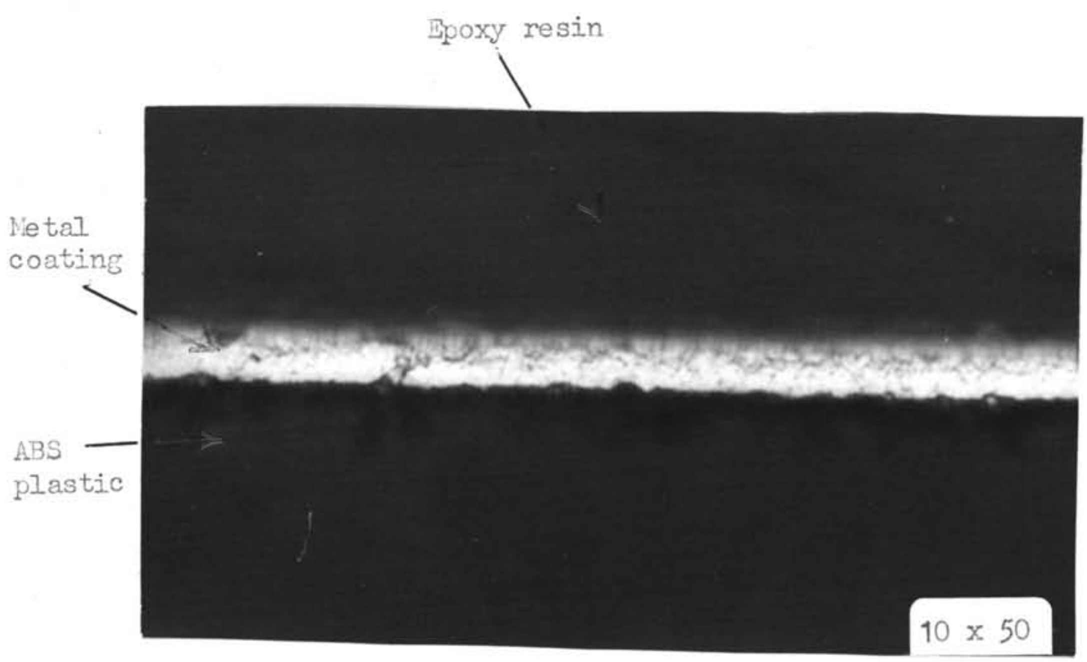


Fig. 5-11 Interlayer structure between ABS plastic and metal coating of specimen run No. 3B



Fig, 5-12 Interlayer structure between ABS plastic and metal coating of specimen run No. 4B

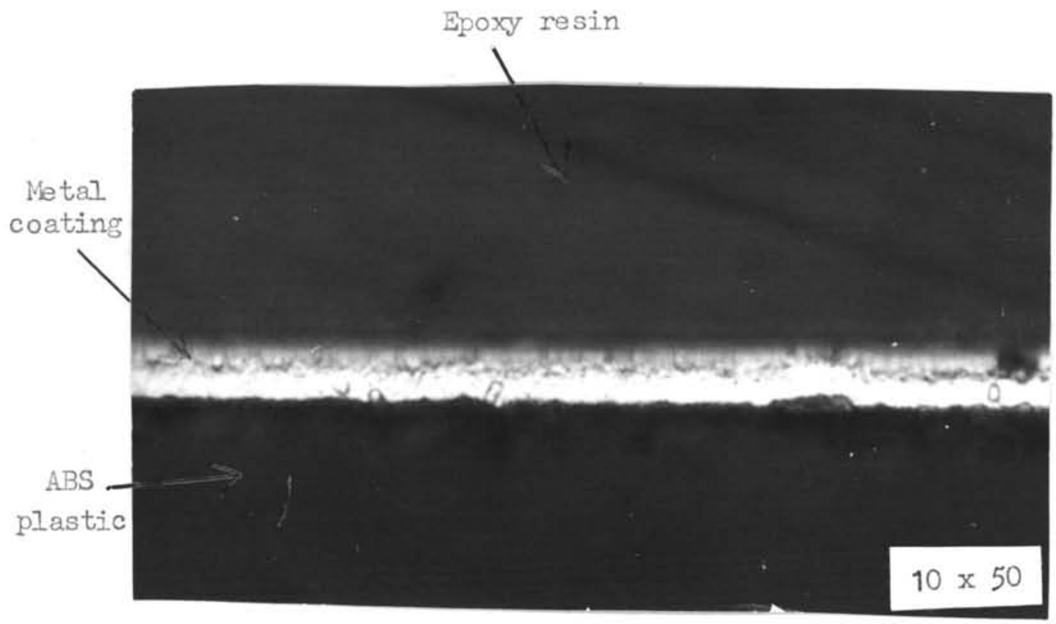


Fig. 5-13 Interlayer structure between ABS plastic and metal coating of specimen run No. 1C

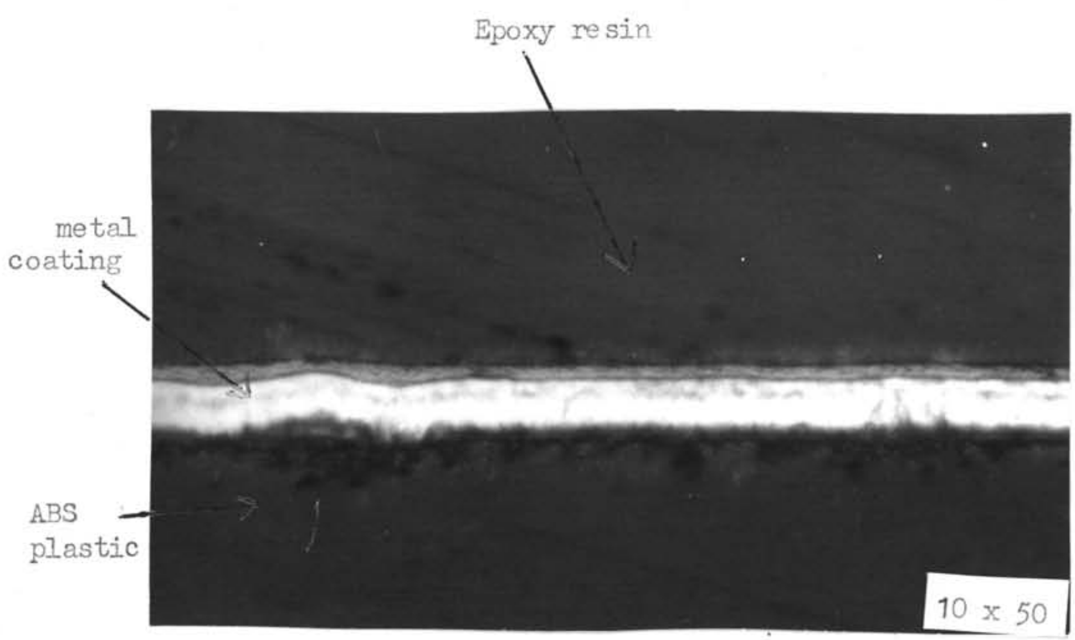


Fig. 5-14 Interlayer structure between ABS plastic and metal coating of specimen run No. 2C

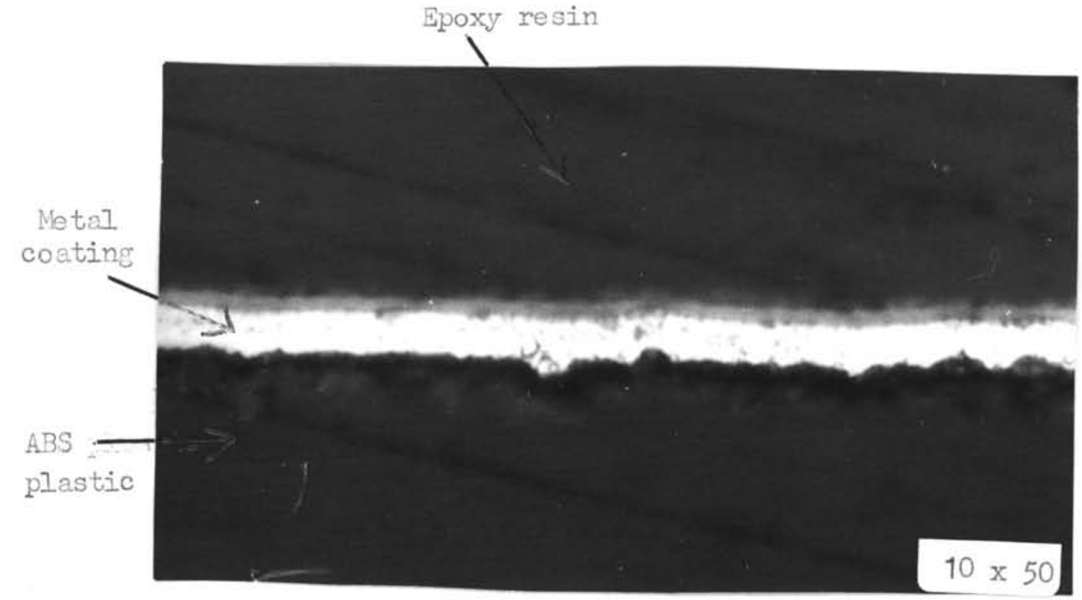


Fig. 5-15 Interlayer structure between ABS plastic and metal coating of specimen run No. 3C

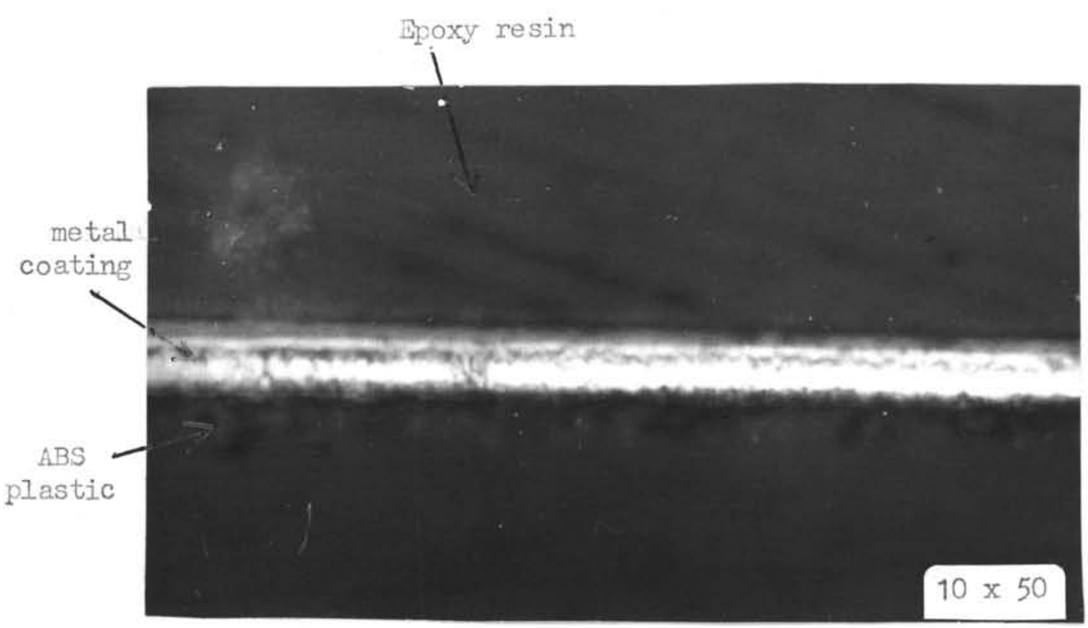


Fig. 5-16 Interlayer structure between ABS plastic and metal coating of specimen run No. 4C

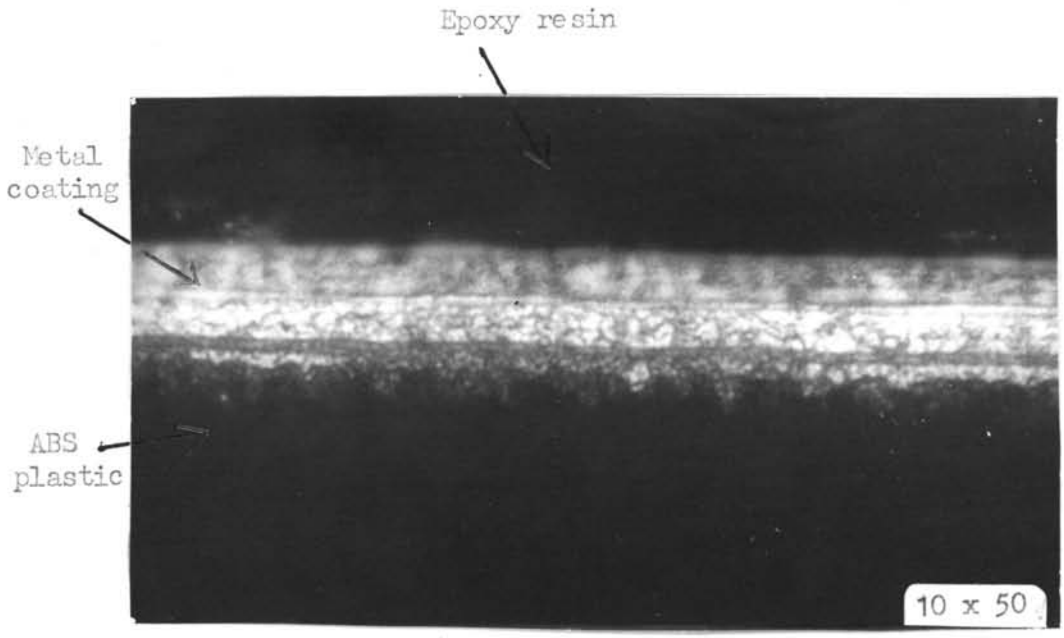
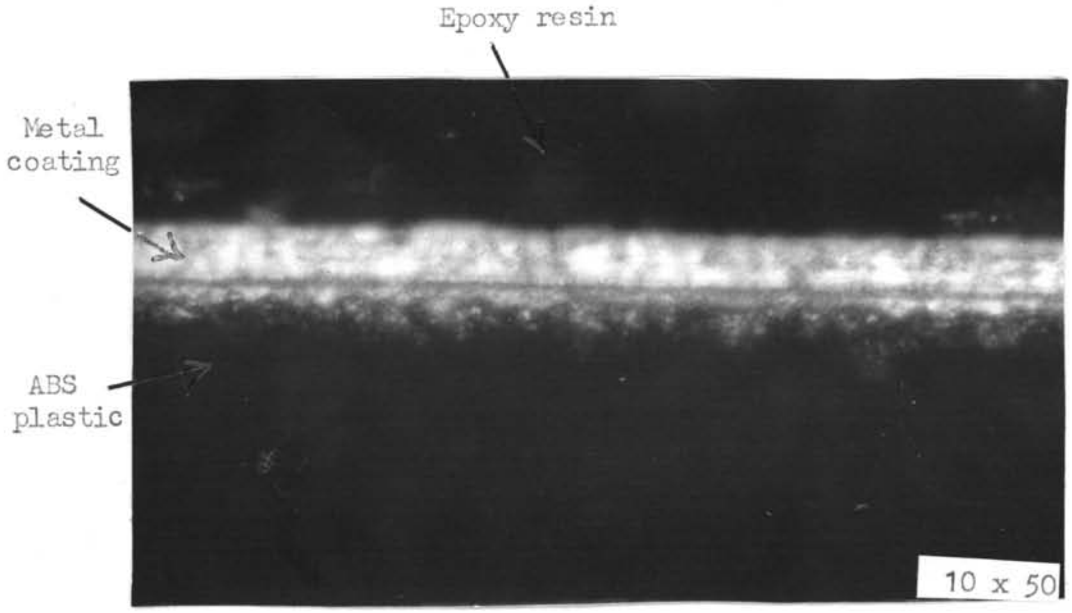


Fig. 5-17 Interlayer structure between ABS plastic and metal coating of specimen run No. 1D

Fig. 5-18 Interlayer structure between ABS plastic and metal coating of specimen run No. 2D



Fig,5-19 Interlayer structure between ABS plastic and metal coating of specimen run No. 3D

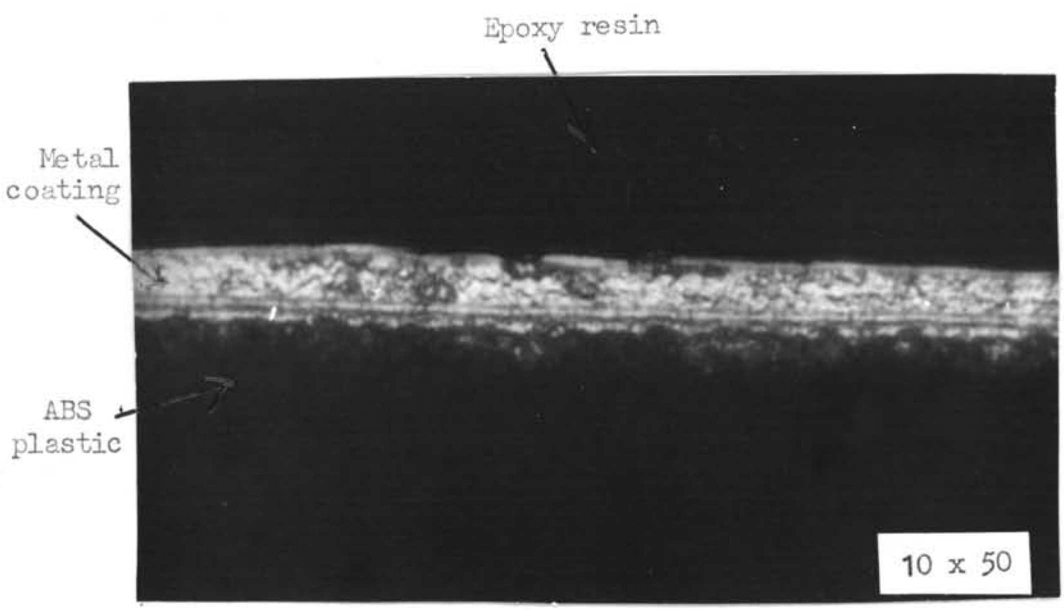


Fig. 5-20 Interlayer structure between ABS plastic and metal coating of specimen run No. 4D