CHAPTER VI

DISCUSSION AND CONCLUSION

Effect of Etching Solution on the Metal/Plastic Adhesion

The present work was intended to study the effect of various etching solutions on the adhesion of metal to plastic substrate. Since it is the etching step which determines the ultimate adhesion of the electrodeposit layer. The etching composition must be properly chosen, thus over-etching can reduce adhesion by unduly weakening the plastic surface layer, and under-etching gives weak adhesion or low peel strength. By using some organic solvents such as ketone, alcohol, and ether, none of them gave successful result since they tend to dissolve and soften ABS plastic, further metallic deposition was not possible. Good result was obtained by using oxidising acid mixtures of chromic acid and sulphuric acid. The oxidising acid mixtures employed, attack the constituents of the plastic in varying degrees. Surface roughness was then produced by these mixtures. Experimental results shown in Fig.5-5 to Fig.5-20 indicate the surface roughness after chemical etching by various compositions of chromic acid and sulphuric acid. From these photomicrographs, it can be seen that metal coating can penetrate and key with plastic

surface by means of surface roughness. Adhesion between metal and plastic has been examined by means of peel strength test. The results in Table 5-4, show that etching composition no. 3 which composes of 420 g/l chromic acid and 380 g/l sulphuric acid gives the highest peel strength indicates the strongest adhesion among the composition tested. The influence of surface roughness can also be discribed by comparing with peel strength data reported in Table 5-4. It can be concluded that bond strength increases with surface roughness. Peel strength values obtained from the experiments were in the range of 1.51 to 2.38 lb/in. Serviceable bond operate from 2 lb/in upwards and an average good standard for most applications including car accessories is 4 lb/in (Walker, 1976). However, the values obtained were not too low as compared with the serviceable values. From these data, etching composition no.3 is suggested to be used as general etching solution.

Corrosion Test by CASS Test

In general, plating on plastics provides great corrosion resistant since there is no galvanic action as in the case of metal coating on the metal substrate. CASS corrosion test was performed on the finished specimens. Neither rust nor oxide scale took place on the surface of the specimens after testing in this severe condition. Visually examination does not show any significant difference, only dirty marks or discoloring was observed on the

surfaces of the specimens. Comparison of these results can be seen in Table 5-5. The samples with nickel electroless treatment show better corrosion resistance than with copper or silver electroless treatment. Blister develop on plated plastic parts when exposed to corrosive environments if electroless copper is used as the initial deposit. Similar blisters have not been observed on electroless nickel plated parts. Coombs (1970) observed loss of adhesion of electroless copper plated ABS plastic when corrosion penetrated through the plate to metal-plastic interface. He proposed that electroless copper was more sensitive to corrosion than electroless nickel which would lead to loss of adhesion. Electroless nickel differs significantly from electroplated nickel, since it is an alloy of nickel and phosphorous, (Swan, 1971). This alloy provides a combination of protection against corrosion.

Conclusions and Suggestions

ABS plastic was selected to be the substrate for this experiment of plating on plastic. Special attention has been paid to the adhesion between plastic and metal layers. The following conclusions can be made out of the experiment:

1. Several organic solvents have been used for pretreatment of plastic surface. None of them showed beneficial effect since they tended to dissolve and soften the plastic surface.

2. Various compositions of chromic-sulphuric acid as oxidising acid for plastic surface pretreatment have been examined..

3. Electroless or chemical plating has been performed on plastic substrate. Copper, acid nickel, alkaline nickel bath using $PdCl_2$ activating solution and copper bath using $AgNO_3$ activating solution have been studied.

4. Subsequent Ni-Cr electroplating has been followed.

5. Adhesion between metal and plastic has been examined by means of peel strength test. The results vary from 1.51 to 2.38 lb/in. Values of peel strength and etching solutions have been plotted, the graph shows that 420 g/l chromic acid - 380 g/l sulphuric acid etching solution gives maximum peel strength on either copper or nickel electroless treatment.

6. From CASS Corrosion Test, the samples with acid nickel electroless layer seem to possess better corrosion resistance. The corrosion was not severe because of the high corrosion resistant nature of the plastic.

7. The keying between plastic and metal has also been investigated by microsectioning technique. The photomicrographs from the reflecting microscope are examined but do not show any significant difference. They only show the penetration of metal to the plastic surface roughness in the crosssectional view of the sample but the after-etched surface of the plastic can't be examined. More sophisticated equipment as scanning electron microscope (SEM) should be suggested for future study to examine the etching effect of the plastic surface. Wedel and LaSala (1977) used Cr(VI) and Cr(III) as etching solution for ABS plastic.