

# Pre-treatment and PTH Solutions for Flex-rigid PCBs

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## Abstract

The demand for flex and flex-rigid boards of ever increasing complexity but at lower costs has never been as high as at present. To be able to compete in such a market requires reliable processes with the capability to handle diverse and emerging materials and designs. This paper will highlight some of the difficulties faced by flex and flex-rigid PCB manufacturers today and will provide working solutions and innovations. Desmear is a common request for flex-rigid materials to ensure good interconnection quality as well as to reduce the comparatively higher costs of plasma processing. The difficulties commonly found with desmearing different lay-ups of flex-rigid will be discussed as well as some useful tips. Pre-treatment is one of the key process steps for ensuring good flex material coverage and adhesion. Several electroless copper pre-treatment concepts as well as a direct concept will be discussed showing the benefits and results for even the most demanding of board layouts and materials.

## Introduction

Due to the different nature of flexible materials and the common requirement to use adhesives it means that manufacturing these boards causes issues not normally faced by standard FR4 PCB producers. The high water absorption, high Tg, chemical resistance and lack of copper adhesion for polyimide are major factors in the difficulty of producing flexible boards. Improvements in the processing of these materials and board types is required especially due to the large increase in flex and flex-rigid board requirements year on year.

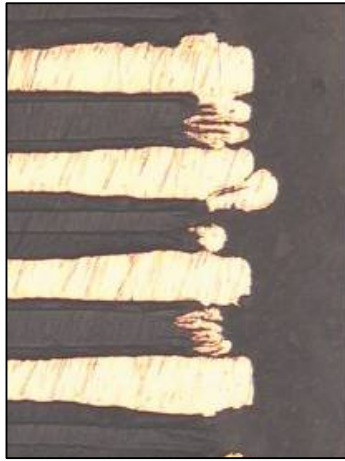
## Desmear

For flex and flex-rigid boards containing polyimide the use of plasma etching for smear removal, adhesion enhancement and surface activation is long known. This technique, however, can be expensive, time consuming and not conducive to mass production requirements, especially for the competitive mobile phone board market. A lot of attention is being made to use permanganate desmear for these board types. The results vary wildly and depend a lot on material choices and build-ups.

**Pictures 1-2 – Multi-flex Rigid Board Plasma Desmear**

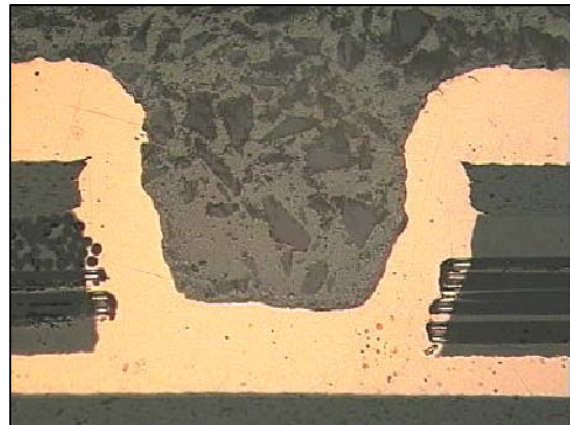
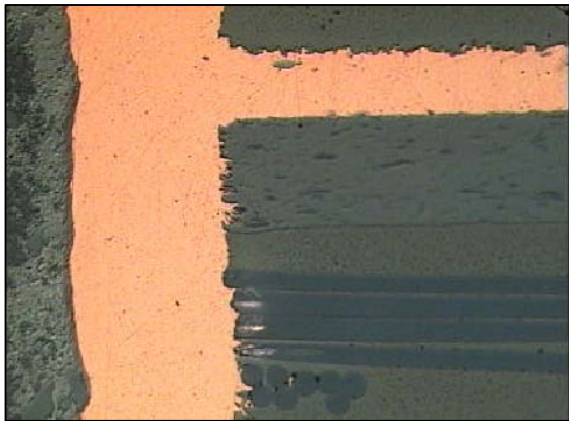


### Pictures 3-4 – Multi-flex Rigid Board Permanganate Desmeared



It is clear to see that the permanganate desmear process has damaged the polyimide and, in this case, also the acrylic adhesive. From backlights and other tests we could determine that the major reason for this aggressive attack was the permanganate etch, not the sweller. This is a common feature of flex desmearing. If the wrong materials are used the attack from standard desmear is so aggressive that you get voids due to high negative etch back and material damage. For certain build-ups the use of standard desmear is possible.

### Pictures 5-6 – Multi-flex Rigid Board Permanganate Desmeared



The above pictures come from a flex-rigid HDI board produced under mass production conditions with standard permanganate desmear and electroless both operated in horizontal mode. The combination of a higher Tg adhesiveless polyimide and high Tg laminate material meant that almost standard processing was possible. The horizontal processing also helped to obtain these good results due to the shorter exposure times and the good waste removal effect of the flooding devices.

In general for desmearing flexible materials the plasma process is preferred due to its universal action on all materials and activating effect on polyimide making it easier to condition and therefore improve coverage. When using permanganate desmearing the polyimide should be of the high Tg variety, acrylic adhesives should be avoided and horizontal processing is preferred. Variations in permanganate desmear parameters can be made to reduce the destructive effect of the permanganate desmear but usually this results in a compromise on desmear performance for the rest of the panel materials and therefore can lead to interconnection defects and reliability issues.

#### Pre-treatment

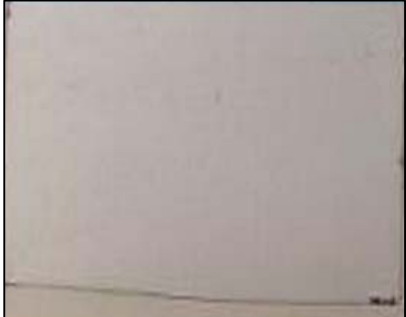
Due to the chemical resistance, wetting difficulty and reduced copper adhesion of polyimide materials and similar flex materials the pre-treatment is critical to achieve good coverage. By developing newer cleaner and conditioning systems the coverage on even the toughest polyimide materials can be greatly improved. The main aim is to make the surface of the polyimide hydrophilic and to activate/condition it sufficiently that good

palladium adsorption and therefore good electroless copper coverage can be achieved. The following pictures show that by improving wetting and conditioning on the latest generation of higher Tg polyimide materials then good coverage can be achieved.

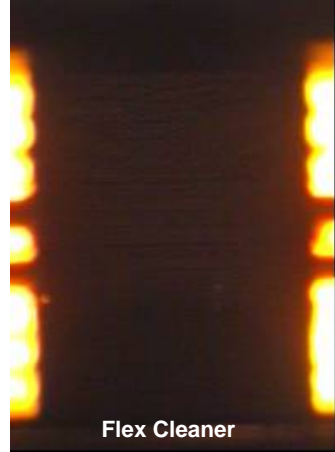
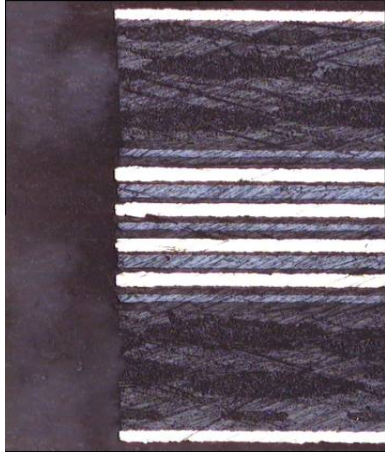
**Pictures 7-8 – Standard Cleaner for Electroless Copper**



**Pictures 9-10 – Improved Flex Cleaner for Electroless Copper**



**Pictures 11-12 – Backlights showing better coverage with Improved Flex Cleaner**



**Electroless Copper**

The electroless copper system has a large influence on the coverage but especially the adhesion on polyimide surfaces. The best electroless copper system for flex processing has to be good at initiating with low palladium activation to get good coverage as well as having a low stress deposit to reduce formation of blisters. Specially developed electroless copper systems like Printoganth P can increase coverage on flex materials and ensure no blisters on even shiny exposed areas of polyimide. This system also has the added benefit that for subsequent acid copper plating obtaining a shiny surface with good appearance is easier to achieve than with standard processes.

**Pictures 13-14 – Standard Low-stress Electroless Copper**



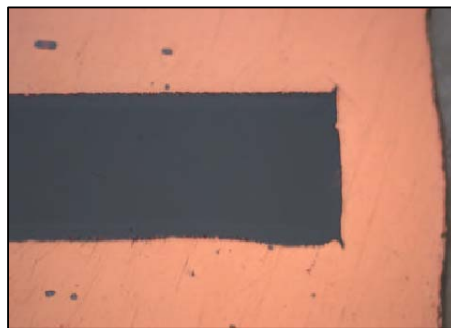
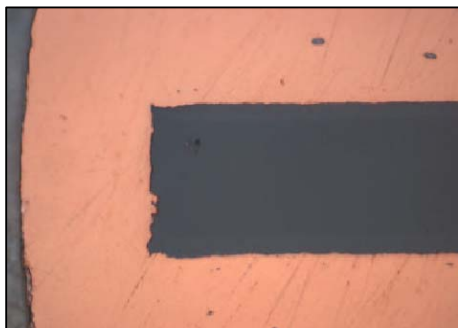
**Pictures 15-16 – Improved Adhesion Low-stress Electroless Copper**



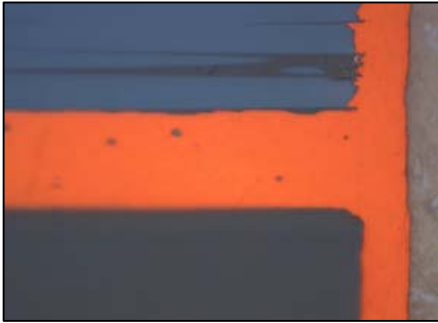
**Direct Metallisation**

Key requirements to get the best results for flex and flex-rigid processing are to have low temperatures, alkalinity and exposure times as well as good flex material wetting and conditioning. Direct plating systems commonly have these useful features and so are ideally suited to flex board production. One of the best systems used for the most difficult flex-rigid boards is the Organic Palladium based direct metallisation system Neopact. This system used horizontally has the best characteristics for use with reel-to-reel flex as well as high technology flex-rigid applications.

**Pictures 17-18 – Organic Palladium DM on DuPont Pyralux AP**



## Pictures 19-20 – Organic Palladium DM on Flex-rigid Board



### Summary

The world of flex and flex-rigid board processing should not be so daunting, there are a lot of very successful solutions to the common problems faced when changing from standard FR4 production into this field. From permanganate and plasma desmear for smear removal, the correct direct metallisation system or electroless copper pre-treatment system for best coverage and the correct choice of electroless copper process for best adhesion and cosmetic appearance there is a system to suit your requirements.

### Acknowledgements

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### References

Flexible PCB Plating Through Hole Considerations, Experiences and Solutions – ECWC 2006, Neil Patton