

PLASMA APPLICATIONS IN THE PRINTED CIRCUIT INDUSTRY

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INTRODUCTION

What is Plasma?

Plasma is partially ionized gases consisting of ions, electrons, free radicals and neutral species. This ionized gas mixture is conductive and highly reactive, which provides the basis for the plasma process.

In circuit board applications the panels are suspended between electrodes. The chamber is evacuated (200 – 300 mTorr), process gas is introduced and the electrodes are energized with RF energy. This initiates the plasma.

APPLICATIONS

Etch Back/Desmear: (The removal of resin smear created from drilling.)

Resin removal from inner layer posts after drilling is required to insure an electrical contact. Plasma processing removes epoxies, polyamides (flex or Rigid), high Tg blends and exotic material such as Bt's and Cynite Estor. This process consists of three gases, O₂, N₂ and CF₄. Three segments are required for sufficient removal of drill smear.

The first segment with O₂/N₂ warms the panel to 80 – 95°C. This is to insure repeatable results from run to run and elevate the temperature of the material where it reacts best with plasma.

Segment 2 uses CF₄, O₂, and N₂. This is where the actual etching part of the process is completed. Temperatures are maintained during this segment to insure the required amount of material is removed.

In segment 3, O₂ is the only gas required. This segment removes any ash and fluorine that was left from segment one and two.

The time in segment two is adjusted to meet desmear or etch back requirements. When etch back is required, a glass fiber removal after plasma is normally done prior to subsequent plating.

Hybrid Multilayers: (PCB consisting of several different materials to accommodate thermal and signal requirements.)

Desmearing panels with mixed material can also be accomplished through plasma. Laminated combinations such as epoxy and Teflon require desmearing and Teflon activation.

Because hybrid panels are partially made up of the same resins as standard rigid panels, the drill smear must still be removed. Teflon does not smear. However, it must be activated in the hole wall to increase wettability. Desmearing and Teflon activation in the same process uses 4 gases and 4 segments.

Segment 1 O₂/N₂, is for warming the panels.

Segment 2, CF₄/O₂/N₂, is for desmearing.

Segment 3, O₂, is for fluorine/ash removal.

Segment 4 activates the Teflon with the use of H₂/N₂ gases.

This allows hybrid panels to be processed for electroless plating in one step. No glass fiber removal is required for this process.

Teflon Activation: (Treating the hole wall to render the surface hydrophilic.) Double sided and multiplayer Teflon through hole activation is accomplished in one or two segments, depending on the material.

Pure blends of Teflon are treated in one segment using H₂/N₂. When Teflons with fillers (ceramic, glass) are used, two segments are required. The filler material has to be pre-etched before the Teflon is activated. In order to do this, CF₄/O₂ is introduced in the first segment, followed by the second segment of H₂/N₂ to activate the Teflon.

Carbon Removal: (Cleaning of capture pads after laser via formation.)

Carbon is a by-product left after laser formation of vias. The carbon must be removed prior to any further processing. Because most laser processes have difficulties forming a clean hole, there is normally some epoxy or polyamide resin mixed with the carbon.

For this reason, the plasma process requires two steps. First, the resin has to be broke down. This is accomplished by using CF_4/O_2 . After the resin has been broken down, the carbon is removed by doing a second segment with AR/O_2 .

Inner Layer Preparation: (Treatment of the inner layer to promote adhesion for laminating.)

Cover coated flexible inner layers yield a difficult surface to laminate to. Plasma helps change the topography and wettability of those inner layers to promote adhesion.

The process is completed with one segment using O_2 .

Special clips or frames are used to hold these thin flexible layers in place during processing.

Panel/Layer Descumming: (Removal of resist residue that was left from circuit image developing process.)

Developing resist off panels and layers with fine pitch sometimes leaves a developer scum between the circuits. If continued on through plating or etching, the resist residue will cause a bridge and short circuits together. Plasma can be used to remove scum from between the fine pitch circuits using only an O_2 process in most cases.

The length of the cycle can be adjusted to compensate for varied thickness amounts that need removal.

Legend Adhesion: (Preparation of soldermask surface prior to applying component nomenclature.)

Some soldermasks yield a poor surface for legend to adhere to. Plasma can create a wettable surface without discoloring the soldermask. Treating is accomplished with O_2 in one segment.

CONSIDERATIONS

There are many benefits in selecting plasma for treating printed circuit boards prior to plating and laminating. Plasma is an environmentally friendly process, which replaces chemicals that require waste treatment and disposal. No chemistry analysis or chemical adds are required as there are with conventional treating methods. Some processes cannot be achieved with chemicals and plasma is required.

Because the plasma process is controlled by software, all the critical parameters are monitored. RF power, gas flow, operating pressure and temperature are all pre-programmed, making plasma repeatable and uniform from run to run.