



DuPont *i*Technologies

Printed Circuit Materials

# DuPont Solder Mask Performance with Assembly Cleaners

VACREL® Photopolymer Film Solder Mask

Technical Bulletin TB-0062

## BACKGROUND

Assemblers use many different types of cleaning chemistries after soldering operations. The choice is dependent upon the type of flux chemistry used. Historically, CFC's and chlorinated solvents were used to clean RA or RMA rosin and synthetic activated (SA) fluxes. Aqueous based cleaners are also used for the R or RMA rosin fluxes as well as for organic acid (OA) fluxes. With the Montreal Protocol eliminating the use of the CFCs, new types of chlorinated solvents and semiaqueous chemistries have been developed to replace the CFCs for cleaning the Rosin based fluxes. Water only aqueous cleaning is being used to clean OA fluxes.

In both internal and external testing DuPont aqueous processable solder mask VACREL® 8100 series has been successfully processed with many solvent based, semiaqueous based, and aqueous based assembly cleaners, when used per standard recommended processes and dwell times.

## GENERAL COMMENTS ON CLEANER COMPATIBILITY

The basic mechanism that causes cleaning solutions to break down solder masks is that the cleaners will swell the mask, until it finally cracks and lifts. This is generally where solder mask coverage is the thinnest such as at the corners of circuit lines or tented/plugged via pads, or at the mask sidewall

interface to a circuit line on a developed out pad.

The solder mask chemistry and thickness are significant in determining the dwell time the masks can withstand in different cleaners before the mask breaks down and lifts. VACREL® 8140 will generally survive longer than VACREL® 8120 in the same cleaner, because it is thicker.

Generally, multiple cleaning cycles can be additive in their effect on the solder mask, unless there is a heat cycle or bake out cycle in between the cleaning cycles. This heat cycle could be a reflow process, or an adhesive bake.

## SOLVENT CLEANERS

DuPont tests show that the amount of time that the solder masked boards are in contact with boiling solvent cleaners is critical. A normal cleaning cycle uses a total of 6 minutes.

Cycle Time	Conveyor System	Batch System
2 mins.	Vapor	Dirty Sump
2 mins.	Liquid	Clean Sump
2 mins.	Vapor	Vapor

If multiple cleaning cycles are used, or if the cleaning cycle dwell times exceed the normal cycles shown, the solder mask may be attacked or lifted off the board.

Internal tests were run using various solvent cleaners. The recommended liquid dwell times for each are listed in TABLE 1.

Based on our testing we would not normally recommend HCFC cleaners with alcohols, such as Genesolve® 2004, due to mask breakdown at very low dwell times.

The following interactions have been seen in the assembly process when solvent cleaning is used.

### **Solder Balls and Solder Webbing**

Chlorinated solvents, especially those containing alcohols, that are used to clean boards prior to wave soldering, can interact with either an Organic Acid (OA) or No-Clean flux, and can cause solder balls or solder webbing on the surface or the solder mask. The flux (mainly isopropanol) interacts with the solvent cleaner remaining in and on the mask surface at the high solder temperature. A bake at 93°C (200°F) for 30 minutes prior to wave soldering, or an adhesive cure, will drive off the solvent, eliminating the problem.

### **Solvent Discoloration**

The solvent in the sump may turn a gray or green color with time. This is a normal occurrence with DuPont solder masks in chlorinated solvents, or in isopropanol and water systems, including ionic test units. The discoloration is caused by the leaching of pigment from the solder mask, and is *not* from solder mask breakdown. Breakdown can occur very quickly in these cleaners if the mask is undercured, and this would also cause severe lifting of the mask.

### **SEMIAQUEOUS CLEANERS**

DuPont internal testing has shown that all thicknesses of VACREL® are compatible with semiaqueous cleaners. DuPont aqueous solder masks remain intact when immersed for over two hours in Axarel®32 cleaning agent at 77°C (170°F) in either an agitated or ultrasonic bath.

Likewise, terpene cleaners such as Bio-Act™ EC-7R, or Ultra had no adverse effects on DuPont masks when tested at standard operating conditions for two hours.

However, alcohol containing cleaners such as Ionox HC™ do effect DuPont masks depending on tem-

perature, concentration and dwell times.

See TABLE 1 for recommended dwell times.

### **AQUEOUS CLEANERS**

Aqueous cleaning in conveyORIZED equipment using heated water with up to 5% saponifier did not attack the solder mask as long as the dwell times are within typical ranges.

In batch mode cleaning, the typical recommendation of 2% saponifier at 49°C (120°F) with a one or two minute dwell time is all that is needed, if it is followed by two or three one minute hot water rinses at 77°C (170°F). Dwell times longer than those listed in TABLE 1 can soften and cause lifting. If the percent solution is reduced or the temperature of the solution is reduced, the mask will be able to withstand longer dwell times than are listed in TABLE 1. However, it is not a direct ratio with % solution, or temperature, so testing would need to be done to determine the dwell time limits at different conditions. The saponifiers tested are listed in TABLE 1.

Aqueous cleaning with isopropanol in water has not caused any mask breakdown problems, however, it can soften the mask surface temporarily. The mask surface will reharden after ten to fifteen minutes of ambient air drying, or oven drying at 93°C (200°F).

TABLE 1

CLEANER TYPES	Recommended Maximum Dwell Times
	<u>8140</u>
<b>Solvent Cleaners*</b> (typically 3 mins. in liquid)	
Freon® TMS, (DuPont)	15 mins.
Prelete® (LONCO)	5 mins.
Propaklone® (ICI)	30 mins.
Genesolve® 2004 (ALLIED)	3 mins.
<b>Semiaqueous Cleaners</b> (typically 3-5 mins. in liquid)	
Axarel® 32 (200°F)	60 mins.
Bio-Act™ EC-7R (100°F)	60 mins.
Bio-Act™ ULTRA (200°F)	60 mins.
IONOX HC™ (130°F)	15 mins.
<b>Aqueous Cleaners</b> (typically 1-2 mins. in spray)	
Alpha® 2110 @ 5% (160°F)	5 mins.
Armakleen® @ 5% (140°F)	5 mins.
Ecosolve® @ 10% (165°F)	5 mins.

**NOTE:** The dwell times indicated have been adjusted to reflect the fact that the solvent attack can be quicker when there is thinner mask coverage due to high plated circuits. Actual time before breakdown was approximately double the recommended times

\*Cleaning Solvents may not be permitted. Check local regulations



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