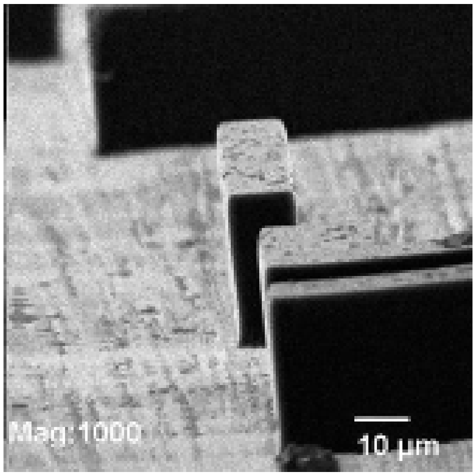
DuPont™ Riston®
Special FX900 Series
DATA SHEET & PROCESSING INFORMATION

High Performance Multi-Purpose Resist Photopolymer Film for Ultra Fine Line Applications



Product Features/ Applications

- Negative working, aqueous processable dry film photoresist.
- Suitable for print-and-etch and tent-and-etch applications with acid and alkaline etchants.
- Ideal for use with very thin-core laminate, including flexible and flex/rigid substrates.
- Compatible with acid copper, tin, tin/lead, nickel sulfamate and acid gold electrolytic plating baths.
- Very high resolution capability with wide processing latitude.

Product Description (Physical Parameters)

Resist Thickness:	20, 30, 38, 50 & 62 µm (0.8, 1.2, 1.5, 2.0 & 2.5 mils)

Unexposed Color in Yellow Light:	Light Green
Exposed Color in Yellow light:	Dark Blue
Exposed Color in Daylight:	Dark Green
Print-Out (Phototropic) Image:	Strong
Contrast to Copper:	Strong
Odor:	Low

The miracles of science™

PART 1: Copper Surfaces & Surface Preparation

Chemical Cleaned Standard Copper Foil or Panel-Plated Copper

Use an alkaline or acid spray cleaner and spray water rinse for removal of organic contaminants, followed by a spray microetchant (0.50-0.75 um; 20-30 uin) and spray water rinse for removing the conversion (chromate) coating and/or copper oxides. To remove residual salts after microetching from the copper surface, a 5-10% sulfuric acid rinse and spray water rinsing should be used, followed by a hot air drying. The final rinse should have a pH of 6 to 8. Mild antitarnish solutions are recommended prior to resist lamination, even on in-line systems, to preserve the cleaned surface. Heavier antitarnish treatments may be required with non-in-line systems where panels are held for several hours or longer.

Chemical Cleaned RTF Copper Foil

Use a commercial one-step tri-acid cleaner followed by thorough multi-chamber water rinsing at a pH of 6 to 8 and hot air drying. The more complex and expensive chemical cleaning process outlined above can also be used, but is not usually necessary. Also, microetching RTF copper reduces its surface roughness.

Unscrubbed Electroless – Post-Electroless Process:

1. Drag-Out Rinses – 2 reverse-cascade overflow tanks for 2 minutes each OR single spray tank for 30 seconds and single overflow tank for 2 minutes.
2. Heated Rinse (Optional) – 50-55C (120-130F) for 3 minutes.
3. Acid Neutralization – 5% sulfuric acid for 5 minutes.
4. Water Rinse – 2 minutes (optional if antitarnish is sulfuric acid-based).
5. Antitarnish – 5 minutes; tank must have a recirculation pump and 10-micron filter. Recommended/Tested Antitarnishes: Duratech Antiox PC-C & PC-L and Enthone Entek Cu-56.
6. DI Final Rinses – 2 reverse-cascade overflow at 35-40C (95-105F) at 2-3 gpm at pH 6-8.
7. On-Line Box Turbine Dryer – 5-10 minutes at 55-65C (130-150F).
8. Fluidhead Turbine Dryer (for high-aspect-ratio plated-through-holes and/or horizontal lines).

Brush Pumice

3F or 4F grade, fused pumice at 15-20 % v/v, 9-12 mm (3/8-1/2") brush foot print, fines removal and replenishment per vendor recommendations; high pressure (10 bar) final rinse (pH 6-8); hot air dry.

Jet Pumice

3F or 4F grade, unfused pumice, 15-20 % v/v, fines removal and replenishment per vendor recommendations; high pressure 10 bar (147 PSI) final rinse (pH 6-8); hot air dry.

Jet or Brush Aluminum Oxide (Al2O3)

Follow vendor recommendations.
***Note*:** To remove antitarnish conversion coatings and/or copper tarnish (oxides), it is recommended to precede jet pumice or aluminum oxide scrubbing with a spray acid cleaner or 10-15% sulfuric acid.

Compressed Pad Brushing

Use 500 grit with a 7-9 mm (1/4 - 3/8") brush foot print and a high pressure (8-10 bar) pH 6-8 final rinse.

Bristle Brushing

Use 500 grit with a 7-9 mm (1/4 - 3/8") brush footprint and a final rinse @ 2-3 bar @ pH 6-8.

***Note*:** Electroplated copper surfaces for tent-and-etch applications are frequently “de-noduled” e.g. by compressed pad brushing prior to pumice scrubbing.

Control Tests

- Water Break Test: ≥ 30 seconds.
- Ra: 0.10-0.30 µm / Rz: 2-3 µm.

Electrochemically Cleaned Copper

Conveyorized systems combining reverse current electrochemical cleaning and microetching can effectively remove chromate conversion coatings with minimal copper etching. The alkaline electrochemical cleaner first removes trace organics and chromates. After a rinse, a microetch removes about 0.8µm (30 microinches) of copper. Following a second rinse an antitarnish may be applied.

Double-Treated Copper Surfaces

Normally no prelamination cleaning is required; vapor degreasing or chemical cleaning to remove organics is optional. Automatic tacky roller cleaning immediately prior to lamination is recommended to remove surface particles.

PART 2: Lamination

HRL Hot Roll Laminator Conditions

- Pre-Heat: Optional for panels > 0.6 mm (> 25 mils) thick.
- Roll Temperature: 105-120°C (220-250°F).
- Roll Speed: 0.6-1.5 m/min (2-5 ft/min).
- Air Assist Pressure: 0-2.8 bar (0-40 psig); for ≥1.7 bar (25 psig) use heavy duty or crowned rolls.

DuPont YieldMaster® 2000 System

- Water Flow Rate/Manifold: 5-15 cc/min.

Use RO, DI or distilled water only, to avoid clogged wet manifolds.

ASL/CSL/DFL Automatic/Cut Sheet/Dry Film Laminator Conditions

- Roll Temperature: 105-120°C (220-250°F).
- Roll Speed: 1.5-3 m/min (5-10 ft/min).
- Lam. Roll Pressure: 3.0-5.0 bars (43-72 psig).
- Seal Bar Temp: 50-60°C (120-140°F).
- Seal Time: 1.5-2.5 seconds.
- Seal Bar Pressure: 2.5-4.5 bars (36-65 psig).

DuPont YieldMaster® 2000 System

- ·Water Flow Rate/Manifold: 5-15 cc/min.

Use RO, DI or distilled water only, to avoid clogged wet manifolds.

Note: Reduced lamination roll pressure and/or temperature may be required in tenting applications to avoid tent breakage and resist flow into through-holes.

Wet-Lamination vs. Resolution

The use of the DuPont YieldMaster 2000 Wet-Lamination System can significantly enhance very fine line resolution. Wet-lamination greatly increases resist image adhesion to the substrate, resulting in the survival of sub-50 micron (2-mil) features without image distortion or dislocation.

Panel Exit Temperature – For Optimum Resist Adhesion and Conformation

1. Innerlayers – Acid or Alkaline: 60-70C (140-160F).
2. Outerlayers – Cu/Sn or Cu/SnPb: 45-55C (110-130F).
3. Outerlayers – Cu/Ni/Au or Ni/Au: 50-55C (120-130F).

Panel Handling/Racking/ Stacking

Outerlayers: Vertical racking in slotted racks.
Innerlayers: Vertical stacking on edge.

Note: Panels must never be stacked horizontally, or random impression defects will be induced.

PART 3: Post-lamination hold time

All photoresists experience some change in photospeed and line widths held over time following lamination. Results differ depending on resist type, duration of hold time and the relative humidity (RH) under which the panels are stored prior to exposure. Low to moderate RH (e.g. 20-50%) has less effect than very high RH (e.g.80-98%). Clearly, maintaining an ambient RH of 50% or less and minimizing post-lamination hold times are the first steps to controlling photospeed and line width change. If production requires unusually long hold times at high humidity, empirical tests to determine the effect should be carried out. Also, use of a routine "first article" process control procedure should be used to automatically compensate for these variations.

Hold time considerations should include:

- Always allow enough time for panels to cool to room temperature prior to exposure to avoid phototool size changes (about 15 minutes). Use a panel accumulator with in-line systems.
- Minimize hold time for best tenting performance.
- Dry lamination maximum recommended hold time = 3 days.
- Wet lamination maximum recommended hold time = 24 hours.

PART 4: Tenting

FX900 (excluding FX920) has been formulated to provide excellent tenting, especially in tent-and-etch applications.

Hole Size : 6mm (250 mils)				
	FX930	FX940	FX950	FX962
% Failure rate after 2 passes through developer	0.5%	0%	0%	0%
% Failure rate after 3 passes through developer & etcher	1.5%	0%	0%	0%

Note: Tenting of very large tooling holes > 6mm (250 mils) may require moderation of resist lamination conditions and a reduction in hold time between resist lamination and exposure.

PART 5: Exposure

Resolution (Lines & Spaces)

In an optimized production environment (hard contact, high intensity and/or fully collimated exposure, correct development control), Riston FX930 can resolve 15 micron (0.6 mil) features.

Exposure Intensity (Inside Vacuum Frame and Though Working Phototool)

- ≥ 5 mW/cm2 for ≥ 125 microns (≥ 5 mils) resolution
- ≥ 10 mW/cm2 for 75-100 microns (3-4 mils) resolution
- ≥ 20 mW/cm2 for < 75 microns (3 mils) resolution

Exposure Energy vs. "Resist Steps Held" For Recommended Exposure Range					
Riston® FX900	FX920	FX930	FX940	FX950	FX962
mJ/cm2	35-105	40-115	45-125	50-140	55-155
RST-25	6-17	6-17	6-17	6-17	6-17
SST-21	6-9	6-9	6-9	6-9	6-9

Exposure Level Selection

- Acid etching and Cu/Sn or Cu/SnPb plating = Lower half of the range.
- Alkaline etching and Cu/Ni/Au plating = Upper half of the range.

Note: All intensity and energy measurements were made at the photoresist surface with an International Light IL-1400A radiometer and an SSD001A Super Slim UV detector probe (275-400 nm sensitivity).

PART 6: Development

Chemistries and Make-up Equations for Working Solutions

- Sodium carbonate anhydrous (soda ash), Na_2CO_3 :
  kg = wt% x sump volume in liters x 0.01
  lbs = wt% x sump volume in gallons x 0.083
- Sodium carbonate monohydrate, $Na_2CO_3 \cdot H_2O$:
  kg = wt% x sump volume in liters x 0.012
  lbs = wt% x sump volume in gallons x 0.10
- Potassium carbonate, anhydrous (potash), K_2CO_3:
  kg = wt% x sump volume in liters x 0.01
  lbs = wt% x sump volume in gallons x 0.083
- DuPont D4000 K_2CO_3 liquid (40% concentrate):
  liters = wt% x sump volume in liters x 0.018
  gallons = wt% x sump volume in gallons x 0.018
- Other K_2CO_3 liquids (various concentrations):
  Consult manufacturer's literature.

Total Carbonate Titration Procedure

Titrate a 25 ml sample of developer solution, without defoamer if possible, with 0.1N HCl to a visual Methyl Orange end point or a pH end point of 3.2. ***Note*****:** The active carbonate pH end point is 4.0.

Wt % = (N x ml HCl x FW) / (20 x ml sample)
N= HCl normality; FW = formula weight
FW of Na_2CO_3 = 106
FW of $Na_2CO_3 \cdot H_2O$ = 124
FW of K_2CO_3 = 138

Development Conditions Resolution >2 mils

- Spray Pressure: 1.4-2.4 bar (20-35 psig).
- Spray Nozzles: High-impact direct-fan nozzles preferred in fixed manifold and rack oscillated equipment. Oscillating manifold equipment suppliers recommend use of cone nozzles.
- Chemistry: 0.7-1.0 wt%; 0.85 wt% preferred.
- Temperature: 27-32°C (80-90°F).

Development Conditions: Resolution < 2 mils

- Spray Pressure: 2.0-2.4 bar (30-35 psig).
- Spray Nozzles: Same as above.
- Chemistry: 0.7-0.8 wt%; 0.75 wt% preferred.
- Temperature: 24 -30C (75-85F).

Dwell Time

- Clean Resist Breakpoint Range: 50 - 65%.
- Total Development Time**:**
  30°C (86F), 1.7 bar (25 psig) spray pressure and 60% breakpoint.

  Riston® FX920: 25 seconds
  Riston® FX930: 30 seconds
  Riston® FX940: 36 seconds
  Riston® FX950: 43 seconds
  Riston® FX962: 50 seconds
- If developer conveyor speed is too fast to match with other in-line equipment (e.g. rinsing or drying):
  first lower temperature to as little as 24C (75F), than reduce carbonate concentration to 0.75%. Do not lower spray pressure below recommended levels. In multi-development chamber units, the first several spray manifolds or the entire first chamber can be turn off.

Defoamers

Riston® FX900 has been successfully used without defoamer. The need for defoamer and the amount required are dependent on water hardness, carbonate purity, resist loading, spray nozzle type and equipment design.
For batch operation: add defoamer during initial make up. For automatic replenishment systems: add defoamer directly to the sump in a high turbulence area and at a predetermined rate. Never add defoamer directly to the supply tank or to the replenishment solution.

Controls

- For batch processing: Adjust conveyor speed to maintain desired breakpoint; dump developer solution when development time becomes 50% longer than with a fresh solution.
- Feed & Bleed: To keep loading at about 0.25 mil-m2 l (10 mil-ft2/gal), activate addition of fresh developer at pH 10.6; stop addition when pH 10.8 is reached. Thus, the pH controller set point = 10.7.

Developer Solution pH Response to Resist Loading for Riston® FX900

pH	mil-m2/liter	mil-ft2/gal
11.2	0.00	0
10.9	0.10	4
10.8	0.20	8
10.7	0.25	10
10.6	0.30	12
10.5	0.40	16

Hold time after development before etching = 0-5 days
Note: Minimize white light exposure during post development hold to prevent film embrittlement.

Rinsing & Drying Recommendations

- Rinse water hardness: 150-300 ppm CaCO3 equivalent. Softer water can be hardened by the addition of magnesium sulfate (Epsom salts).
- Rinse temperature: 21-25°C (70-80°F)
- Rinse spray pressure: 1.4-2.4 bar (20-35 psig). Use only high impact, direct-fan nozzles.
- Develop-to-Rinse Length Ratio: 2:1 minimum.
- Drying: Fluid head or hot air turbine drying is preferred.

Developer Maintenance

Clean at least once a week to remove resist residues, calcium carbonate (hard water scale), defoamer, and dye from developed resist. Dye build-up can be minimized by the use of antifoam. In-line cartridge filters (25-50 micron) should be used on all spray chambers, developer and rinse. Filter canisters should be sized to minimize spray pressure loss.

PART 7: Post-Development Curing

These optional process steps can be used to assure full resist adhesion and chemical resistance during severe gold plating cycles, such as very thick deposits > 1.5 um (> 60 microinches), low bath efficiency < 50%, high current density > 1.0 amps/sq dm (> 10 amps/sq foot) or high-pH soft gold solutions. These curing steps do not significantly increase strip rate.
Note: Baking is more effective than UV-bumping.

Bake Cycle: 120C (250F) for 10 to 15 minutes.

OR

UV-Bump Cycle: 100-150 mJ/cm2 via blank exposure.

PART 8: Etching

Riston® FX900 series resists are fully compatible with most acid etchants, such as cupric chloride (free HCl normality ≤ 3.0 N) and ferric chloride, and most alkaline etchants (pH = 7.8 – 8.8).

PART 9: Pattern Plating

Riston FX900 can be used for pattern plating with acid copper, tin/lead, tin, nickel sulfamate and most acid gold baths. FX900 has very strong resistance to lifting/underplating and organic leaching.

Preplate Cleaning Process Sequence

- Acid hot soak cleaner: 38-50C (100-120F) for 2-4 minutes.
- Spray water rinse: 2 minutes.
- Microetch: 0.15-0.25 um (5-10 uin).
- Spray water rinse: 2 minutes.
- Sulfuric acid: 5-10 vol% for 1-2 minutes.
- Optional spray water rinse: 1-2 minutes.

Gold Plating Requirements

- Plating bath gold content must be maintained at the high end of the supplier's recommended range, typically 8-10 grams/liter (1.0-1.2 Troy oz/gal). This will optimize bath efficiency, while minimizing the formation of hydroxyl ions at the cathode (the panel's surface) and preventing the damaging attack of the resist's sidewalls. Gold content below 7 grams/liter (0.8 Troy oz/gal) has been found to cause resist image failure with all aqueous dry film photoresists.
- Vigorous solution agitation is required under the anode and cathode areas. Pump the filter effluent through multiple sparger tubes and mechanically agitate the cathode.
- Bath temperature, pH and current density must be held within supplier specifications, typically 32-43C (90-110F), pH 3.0 – 5.0 and 0.5-1.0 amps/sq dm (5-10 amps/sq ft).

PART 10: Stripping

Aqueous Caustic (NaOH or KOH) Conveyorized Stripping

- Total Stripping Time at 55°C (130°F), 1.7 kg/cm2 (25 psig) spray pressure and 50% breakpoint.

Developer Solution pH Response to Resist Loading for Riston® FX900

	FX920	FX930	FX940	FX950	FX962
1.5 wt% NaOH	30 sec	45 sec	75 sec	125 sec	200 sec
3.0 wt% NaOH	18 sec	30 sec	50 sec	85 sec	145 sec

- High caustic concentrations produce larger skin sizes, higher loading capabilities and longer strip times.
- KOH generally produces smaller skin sizes than NaOH.
- Physical characteristics of stripped particles: hard, non-sticky.
- Higher stripping temperatures significantly increase the stripping rate.
- Stripping rate can also be increased with higher impact direct fan spray nozzles.
- Stripping rate decreases with pre-strip white light exposure. A 20% increase in strip time over several days of exposure is not unusual.

Defoamers

Additives for foam control may not be required depending on equipment design and operation. However, if defoamer is needed, use 0.8 ml/ liter (3 ml/gallon) for resist loading up to 0.6 mil-m2/liter (25 mil-ft2/gal).

Controls/ Solution Maintenance

- **Preferred:** Continuous replenishment (feed & bleed) using board counter.
  Maintain resist loading at ≤ 0.4 mil-m2/liter (≤ 15 mil-square feet/ gallon).
- **Batch:** Up to 0.5 mil-m2/liter (20 mil-square feet/gallon).
  Maintain breakpoint at ≤50% by lowering conveyor speed or by starting batch stripping with a lower breakpoint and changing the solution once breakpoint moves beyond 50%. However, low breakpoints can lead to attack of solder or tin on plated work, or cause copper oxidation on print-and-etched or tent-and-etch panels.
- **Filtration Systems:** Spray stripping equipment should contain a filtration system to collect and remove resist skins to avoid nozzle clogging, to extend stripper life, and to avoid resist skins from reaching the rinse chamber. The most effective filter systems collect the resist skins continuously off-line, immediately after they were generated and before entering recirculation pumps.

Equipment Cleaning

Cleaning of equipment drain and flush with water: Fill unit with 5 wt% KOH or NaOH, heat to 55°C (130°F), and circulate (spray) for 30 minutes to dissolve photoresist particles. Then drain the unit. Repeat procedure if required to remove heavy residues. Remaining blue dye stains on equipment may be removed by circulating 5 vol % HCl at 55°C (130°F) for 30 minutes (HCl can damage stainless steel). Then drain the unit, fill with water, recirculate for 30 minutes, and drain. There are also proprietary cleaners available that may offer better results.

Proprietary Strippers

Proprietary chemistries are used for higher strip speeds, higher resist loading and smaller particle size. They also minimize chemical attack on tin or tin/lead and reduce copper oxidation to facilitate AOI analysis. Operating temperatures are between 50C and 65C (125F and 150F).

Reworking Panels for Re-Use

Stripped panels may have organic residues from the photoresist or defoamers and/or oxidation stains. Pumice or aluminum oxide scrubbing or chemical cleaning with a microetch may be required to regenerate the copper surface prior to re-imaging. If the surface is residue and stain-free, the standard precleaning process may be sufficient.

Storage & Safe Lighting

See recommendations in the General Processing Guide *(DS98-41).*

Processing Data

This Data Sheet documents specific process information for Riston® FX500 Series. Data quoted in this guide have been generated using production equipment as well as laboratory test methods and are offered as a guideline. Actual production parameters will depend upon the equipment, chemistries, and process controls in use, and should be selected for best performance. For more background on general Riston® processing see the General Processing Guide *(DS98-41).*
For additional information on DuPont's products for Printed Wiring Board fabrication, visit our web site at http://www.dupont.com/pcm.

Safe Handling

Consult the Material Safety Data Sheet (MSDS) for Riston® dry film photoresist vapors. The vapor MSDS for this film was prepared using the highest lamination roll temperature recommended for use. If you choose to exceed this temperature, be aware that the amount of vapor may increase and that the identity of the materials vaporized may vary from those in the MSDS. For more Safe Handling information, see publication TB-9944 "Handling Procedure for DuPont Photopolymer Films".

Waste Disposal

For questions concerning disposal of photoresist waste refer to the latest DuPont literature and Federal, State, and Local Regulations.

For further information on, please contact your local representative.

DuPont Electronic Technologies
14 T. W. Alexander Drive
Research Triangle Park, NC 27709 USA

www.imaging-materials.dupont.com

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