

DuPont™ Riston® EtchMaster™ EM213

DATA SHEET & PROCESSING INFORMATION

Photopolymer Film for Print and Etch application with Acid Etching, including Photochemical Machining.

Product Features/ Applications

- Negative working, aqueous processable dry film photoresist.
- Fine Line capability with wider processing latitude.
- High Productivity
- Suitable for print and etch application with acid etching, including photochemical machining.

Product Description

(Physical Parameters)

Resist Thickness:	30 micron
Unexposed Color in Yellow Light:	Gray-blue
Exposed Color in Yellow light:	Blue
Exposed Color in Daylight:	Dark blue
Print-Out (Phototropic) Image:	Good
Contrast to Copper:	Very good
Odor:	Medium



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PART 1: Copper Surfaces & Surface Preparation

Vendor Copper (Print & Etch)

Scrubbed Vendor Copper

To remove vendor applied antitamish conversion coatings (e.g. chromate conversion coatings) and/or copper tarnish (oxides), it is recommended to precede pumice or aluminum oxide scrubbing with a spray acid cleaner or 10-15% sulfuric acid or a microetch.

Chemically Cleaned Vendor Copper

Low Foam Alkaline Spray Cleaner for removal of organic contaminants followed by a spray microetchant for conversion coating (chromate) and/or copper oxide removal (about 2-2.5 μm ; 80-100 microinch etch). A 10% sulfuric acid spray may be used between alkaline cleaner and microetchant to help with the conversion coating removal. In this case only 1.5 μm (60 microinch) microetch depth is required. To remove residual salts from the copper surface after microetching the copper surface, dilute sulfuric acid rinsing or efficient water spray rinsing have been employed successfully. In-line systems for prelamination cleaning may not require an antitamish treatment after chemical preclean to preserve the cleaned surface if hold time prior to lamination is held to less than 4 hours; longer hold times will require antitamish.

Antitamish Applied

The following antitamishes have been used successfully per manufacturers recommendations:

- Enthone Entek Cu56
- Duratech PCL

Electrochemically Cleaned Vendor Copper

Conveyorized systems combining reverse current electrochemical cleaning and microetching are offered to effectively remove chromate conversion coatings with minimal copper removal. The alkaline electrochemical cleaner first removes about 0.8 μm (30 microinches) of copper. Following a second rinse, an antitamish may be applied.

Double-Treated Copper Surfaces

Normally, no prelamination cleaning is required; vapor degreasing or chemical cleaning to remove organics is optional. Tacky roller cleaning is recommended to remove particles.

PART 2: Lamination

Riston® EM213 film is formulated specifically as an acid print and etch film. It is compatible with wet lamination.

Lamination Conditions DuPont HRL-24 & HRL-24/Yieldmaster® Film Laminator

- Pre-Heat: Optional
- Roll Temperature: 110 °C \pm 5°C(230 \pm 9°F)
- Roll Speed: 0.6-1.5 m/min (2-5 ft/min)
- Air Assist Pressure: 0-2.8 bar (0-40 psig)

Note: for • 1.4 bar use heavy-duty rolls)

- Water Flow Rate, each valve (Yieldmaster® models only): 5-15 cc/min

Note: Use distilled water. Hard water is acceptable but may cause scale build up and clog wetting tube nozzles.

Laminator Conditions

DuPont ASL-24 & ASL-24/Yieldmaster® Film Laminator

- Seal Bar Temp.: 65 \pm 15°C (150 \pm 27°F)
- Lam. Roll Pressure: 3.0-5.0 bar (43-72 psig)
- Lamination Temp.: 110 \pm 5°C (220 \pm 9°F)
- Seal Time: 2-4 secs
- Seal Bar Pressure: 3.5-4.5 bar (50-65 psig)
- Lamination Speed: 1.5-3 m/min (5-10 ft/min)
- Water Flow Rate, each valve (Yieldmaster® models only): 5-15 cc/min

Note: Use distilled water. Hard water is acceptable but may cause scale build up and clog wetting tube nozzles.

Post-Lamination Hold Time

- Panels may be exposed immediately after lamination; however, allow enough time for panels to cool to room temperature before exposure (about 15 minutes; use accumulator in in-line systems).
- Maximum hold time (guidelines):
Wet Lamination: 24 hours
Dry Lamination: up to 3 days

Hold times should be determined empirically based on the temperature and relative humidity of the storage area.

Note: Guideline- strip within 5 days after lamination.

Panel Handling/Racking/ Stacking

For the highest possible yield, panels should be placed vertically in slotted racks after cooling. Since this is usually incompatible with high productivity automated lines, an acceptable alternative is near-vertical stacking, which reduces pressure between panels and thus minimizes potential resist damage (impressions) from particles trapped between panels. Minimize panel handling, to prevent migration of particles from panel edges. The warmer the panels, the softer the resist and the greater the effect of particle impressions, so it is desirable to cool panels to room temperature before stacking. Horizontal stacking is undesirable, but if it is unavoidable, stack height and hold time must be severely limited.

PART 3: Exposure

The "resolution" data given here represent the smallest lines and spaces where reasonable yields might be attained on full size panels with Riston® EM213 photoresist. They do not represent the finest space which can be resolved nor the finest resist line remaining intact after image development.

Resolution (Lines & spaces; L/S) for Riston® EM213

- In Optimized Production Environment (hard contact, high intensity exposure, good development and rinse control): 70 micron (2.8 mil) L/S
- In Lab Environment: 55 micron (2.2 mil L/S)

Phototool (3 mil) line reproduction with Riston® EM213

- 1:1 reproduction at RST 15
- Resist line 5 micron (0.2 mil) wider at RST 18
- Resist line 5 micron (0.2 mil) narrower at RST 13

Note: DuPont PC-130; Off-contact = distance between Mylar® cover film and phototool emulsion side.

Exposure Intensity

- ≥ 5 mW/cm² at the photoresist surface for 200-250 μ m (8-10 mil) L/S resolution; higher intensities are desirable for finer L/S.

Exposure Energy vs "Steps Held"

Riston® EM213	
mJ/cm ²	25 – 50
RST25	12 – 18
SST21	8 – 10

For Recommended Exposure Range

- Steps held can vary by +/-1 RST depending on the development breakpoint used.
- If panels are exposed when warm, there may be a slight increase in the steps held.

Note:

- Radiometer: International Light, Radiometer probe: XR140B;
- Printer: DuPont PC-130;
- RST = DuPont Riston® 25-Step Density Tablet;
- SST = Stouffer 21-Step Sensitivity Guide;
- "Step Held" = last step covered +50% with photoresist.

Vacuum Frame Operation

- Preferred Contact Mode: Hard Contact
- Check for small, immovable, Newton's Rings as an indicator of good contact between the panel, photo-tool, and vacuum frame cover
- Use air bleeder veins to channel air to vacuum port and reduce vacuum drawdown time.
- Bleeder Vein Thickness: same as panel

Partial Exposure

Partial polymerization of resist can generate developer residues which in turn cause copper spots in etching. Partial light blockage in exposure frames by registration tooling, etc., can be a serious problem in both manual and automated exposure units, and must be avoided. Ideally, all exposed resist should be the same color, with good definition after development. Color fade in certain places after development indicates partial exposure from light blockage, which can cause developer residue and copper spots. For a print and etch process, this can usually be prevented by modifying artwork designs or by installing physical barriers to completely block light at problem locations.

PART 4: Development

Chemistries/Make-up

- **Sodium carbonate, anhydrous, (soda ash); Na₂CO₃**
Working solution: 0.85 wt%. Use 8.5 g/l (0.071 lb./gal; e.g. for a 20 gallon sump use 1.42 lb.)
- **Sodium carbonate, monohydrate; Na₂CO₃•H₂O**
Working solution: 1.00 wt%. Use 10 g/l (0.083 lb./gal; e.g. for a 20 gallon sump use 1.66 lb.)
- **Potassium carbonate (potash); K₂CO₃**
For make up use either potassium carbonate powder, i.e. anhydrous (potash) K₂CO₃, or a liquid concentrate such as DuPont D-4000 developer (40% concentrate). Working solution: 0.85 wt%. For 100 liter solution use 1.5 liter of D-4000 or 0.85 Kg of anhydrous potassium carbonate (For 100 gal solution use 1.5 gal of D-4000 or 7.06 lb. of anhydrous potassium carbonate).

Equations to calculate required amounts for desired wt% of working solutions:

- **Na₂CO₃:**
kg Na₂CO₃ = wt% x sump volume in liters x 0.011b.
Na₂CO₃ = wt% x sump volume in gallons x 0.083
- **D-4000:**
liters (or gallons) D-4000 = wt% x sump volume in liters (or gallons) x 0.018
- **K₂CO₃:**
kg K₂CO₃ = wt% x sump volume in liters x 0.01 lb.
K₂CO₃ = wt % x sump volume in gallons x 0.083

Control Test:

Titration of fresh developer solution (e.g. 25ml), before defoamer addition, with 0.1 N HCl to the Methyl Orange end point.

$$\text{wt}\% = \text{N} \times \text{ml HCl} \times \text{FW} / 20 \times \text{ml Sample}$$

(N= acid normality; FW = formula weight)

$$\text{FW of Na}_2\text{CO}_3 = 106$$
$$\text{FW of Na}_2\text{CO}_3 \cdot \text{H}_2\text{O} = 124$$
$$\text{FW of K}_2\text{CO}_3 = 138$$

Defoamers

Riston® EM213 has been successfully used without defoamer. The need for defoamer and the amount required are dependent on water quality, carbonate purity, photoresist loading, and equipment design. If required to control foam, add 0.8 ml/liter (3 ml/gallon) polyethylene-polypropylene glycol block co-polymer.

- For batch operation: add defoamer during initial make up; For automatic replenishment systems: add defoamer directly to the sump in a high turbulence area at a predetermined rate. Do not add defoamer to the supply tank or to the replenishment solution.

Development Conditions

- Spray Pressure: 1.4-2.4 bar (20-35 psig)
- Spray Nozzles: high impact direct-fan nozzles preferred; a combination of cone and fan nozzles may be preferred if film tent breakage is experienced.
- Chemistry:

Na ₂ CO ₃ :	0.7-1.15 wt%; 0.85 wt% preferred
Na ₂ CO ₃ ·H ₂ O:	0.8-1.1 wt%; 1.0 wt% preferred
K ₂ CO ₃	0.75 -1.0 wt%; 0.9 wt% preferred

Note: The use of buffered development solutions, containing KOH (Potassium Hydroxide) or NaOH (Sodium Hydroxide), is not recommended with DuPont Riston® Photoresists. These solutions can lead to excessive foaming and high dissolved photoresist loading, compromising sidewall quality and photoresist resolution. Also, use of buffered chemistries can increase residue buildup in the developer, resulting in increased weekly equipment clean-out costs.

- Temperature: 27-35°C (80-95°F); 30°C (85°F) preferred

Dwell Time

- Breakpoint: 50-70 % (60 % preferred)
- Time in Developer (Dwell Time), at 2.0 bar (30 psig) spray pressure, 60 % breakpoint, 30°C, fresh developer solution at 1.0% sodium carbonate concentration in a Chemcut 2000 developer

Riston® EM213 : 22 Seconds

Note: Total time in developer = Time to clean divided by Breakpoint. (Breakpoint expressed as a fraction, e.g., 60% = 0.60)

- Time to Clean (time in developer to wash off unexposed resist): 60% of dwell times.
- Shorter times to clean are achieved at higher temperatures, higher carbonate concentrations, and higher spray pressures.

- If developer conveyor speed is too fast for a match with other in-line equipment: lower soda ash concentration down as far as 0.5wt%. Consider lowering temperature. Do not lower spray pressure below recommended levels.
- Short dwell time in the developer is desirable because it minimizes solution attack on resist sidewalls after they are completely formed. If dwell time exceeds 40 seconds, spray pressure should be increased to reduce dwell time (2.2 bar max. pressure). If the resulting faster development speed creates an excessive conveyor speed mismatch with the etcher, consider plugging some sprays near the developer entrance, so that the developer conveyor can be slowed while still keeping the effective dwell time below 40 seconds.

Avoid operation below pH 10.5, as resist time to clean may increase quickly below that pH.

Note: Lower loadings result in shorter time to clean; higher loadings increase the time to clean.

Rinsing & Drying Recommendations

- Rinse water: hard water (150-250 ppm CaCO₃ equivalent). Softer water can be hardened by the addition of calcium chloride or magnesium sulfate. If hard water is not available, a first soft water rinse may be followed by a dilute sulfuric acid rinse, followed by a water rinse.
- Rinse temperature: 15-25°C (60-80°F)
- Rinse spray pressure: 1.4-2.4 bar (20-35 psig). Use high impact, direct-fan nozzles.
- Effective Rinse Length: 1/3-2/3 of length of developer chamber; >1/2 preferred.
- Drying: blow dry thoroughly; Hot air preferred

Controls:

- For batch processing: adjust conveyor speed to maintain desired breakpoint; dump developer solution when development time has become 50% longer than for fresh solution.
- Developer conveyor speed: see "Dwell Time"
- Feed & Bleed: to keep loading at about 0.13 mil-ft²/l (5 mil-ft²/gal), activate addition of fresh developer at pH 10.5; stop addition when pH 10.6 is reached.

Note: pH for loaded solutions not yet available.

Hold Time after Development before Etching

0-5 days

Note: Minimize white light exposure during post development hold to prevent film embrittlement.

Developer Residue

Partial polymerization of resist can generate developer residues which in turn cause copper spots in etching. Partial light blockage in exposure frames by registration tooling, etc., can be a serious problem in both manual and automated exposure

units, and must be avoided. Ideally, all exposed resist should be the same color, with good definition after development. Color fade in certain places after development indicates partial exposure from light blockage, which can cause developer residue and copper spots. For a print and etch process, this can usually be prevented by modifying artwork designs to prevent this or by installing physical barriers to completely block light at problem locations.

Developer Maintenance

Clean at least once a week to remove resist residue, calcium carbonate (scale), defoamer, and dye from developed resist. Dye buildup can be minimized by the use of anti-foam. The sump cleaning procedure recommended in the STRIPPING Section under Equipment Cleaning may be also used for the Developer, **provided that 40°C (104°F is used instead of 55°C (130°F).**

PART 5: Acid Etching

- Riston® EM213 resist is compatible with most acid etchants, e.g. cupric chloride (free HCl normality ≤ 3.0 N), H_2O_2/H_2SO_4 , and ferric chloride.

Sometimes, unusual combinations of resists and antifoams from development can dissolve in etchant, then redeposit on etcher walls, conveyors and panels. These materials, sometimes called etcher "goo", can retard etching, resulting in shorts and spurious copper. Recirculating etchant through carbon filters has been successfully used to remove such materials. This method is described in Riston® Technical Bulletin H-43326, while Riston® EM213 is not prone to these problems, there is always a possibility that it may occur under some circumstances.

PART 6: Stripping

Riston® EM213 film is formulated not to dissolve in caustic stripping solution after breaking up into pieces. This can greatly increase the life of stripping solution and reduce costs. Aqueous Caustic (NaOH or KOH) Conveyorized Stripping

- Stripper Dwell Time at 55°C (130°F), 1.7 kg/cm² (30psig), over recommended exposure range:

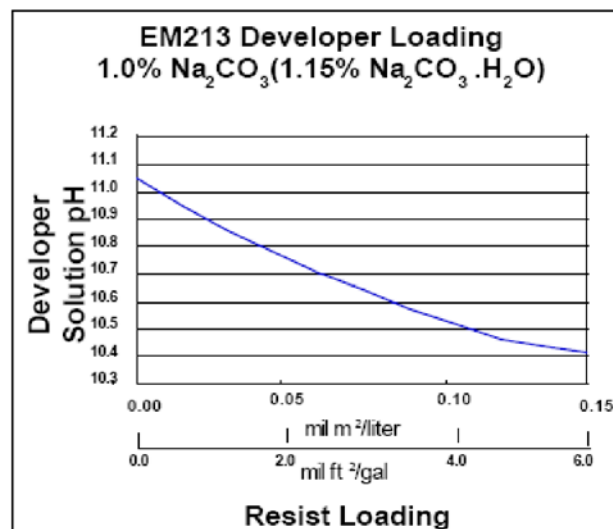
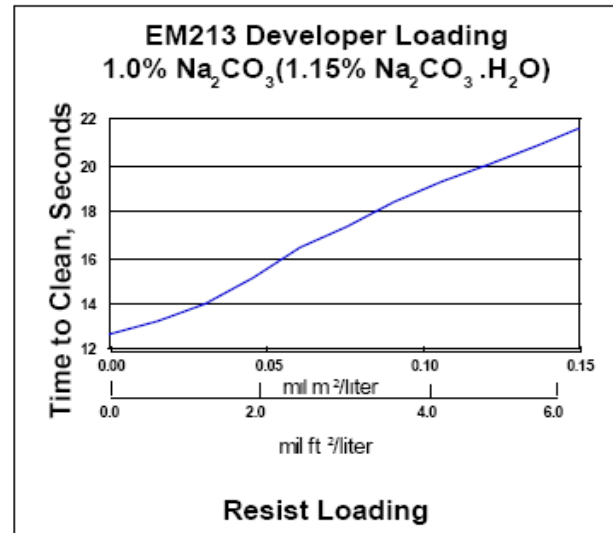
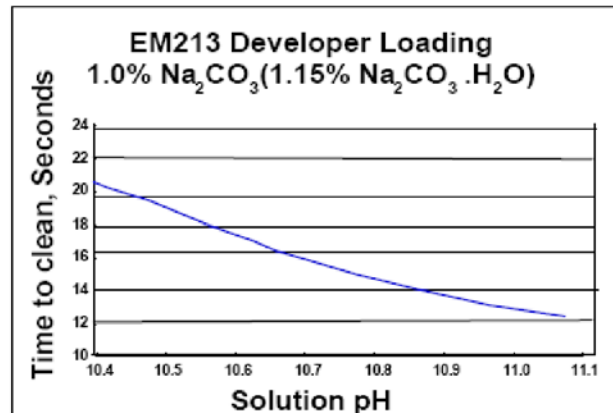
Stripper Dwell Times for Riston® EM213 (at 50%BP)

3.0 wt% NaOH	68 sec
3.0 wt% KOH	73 sec
1.5 wt% NaOH	115 sec
1.5 wt% KOH	146 sec

Note:

- Dwell Time = 2x Time to strip resist
- High caustic concentrations produce larger skin sizes and higher loading capabilities.
- KOH generally produces smaller skin sizes than NaOH.
- Monoethanolamine (MEA) may be added at 1-3% by weight to 3% NaOH solution to reduce staining which may interfere with automated Optical Inspection (AOI).

Resist Loading



Particle Size at 3.0% NaOH:	>3mm
Particle Size at 1.5% KOH:	1-2mm

- Solubility of Stripped Particles: Very Low
- Rate of dissolution of Stripped Particles: No dissolution in 48 hrs.
- Higher stripping temperature increases the stripping rate
- Stripping rate can be increased with higher impact sprays. Use higher pressures and/or high-impact spray nozzles. Avoid low impact deflector nozzles.
- Time to strip increases with white light exposure. A 20% increase in strip time over 8 days 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 at 0.5 ml/ liter (2ml/gal) for resist loadings up to 0.6 mil-m²/liter (25 mil-ft²/gal).

Controls/ Solution Maintenance:

- Preferred: Continuous replenishment (feed & bleed) using board count.
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 $\leq 50\%$ by lowering conveyor speed or by starting batch stripping with a lower breakpoint and changing the solution once breakpoint moves above 50%. However, low breakpoints can lead to attack of solder on plated work, or cause copper oxidation and stains which may interfere with AOI.
- 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 prevent resist skins from reaching the rinse chamber. The most effective filter systems collect the stripper skins immediately after they are generated, before entering recirculation pumps, and they feature continuous removal of skins from the stripper solution.

- Riston® EM213 film is formulated to obtain relatively insoluble skins in stripping. This can extend stripping solution life greatly. However, machines which do not have automatic skin removal, filter baskets may have to be emptied more frequently to prevent filter "blinding".

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 which may offer better results.

Proprietary Strippers

Are used for higher strip speed, higher resist loading, or to reduce copper oxidation, or staining e.g. to reduce AOI false errors.

Storage & Safe Lighting

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

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, please contact your local representative.

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