TECHNICAL DATA

DUPONT

Circuit Imaging

Riston® DI3000
Data Sheet and Processing Information
Riston® Photopolymer Films

PRODUCT FEATURES/APPLICATIONS

- Negative working, aqueous processable dry film photoresist
- Suitable for Multiple wavelength direct imaging **with tenting requirement**
- Vivid print out image after exposure for easy inspection.
- Suitable for **Tent & Etch** and **Plating** application with high acid resistance performance for better yields

STORAGE

Temperature:	5–21 °C (40–70 °F)
Relative Humidity:	30–70%

Keep films covered with black-plastic at all times even under yellow room lighting.

PRODUCT DESCRIPTION (Physical Parameters)

Available Thickness:	25 µm (1.0 mil) 30 µm (1.2 mil) 38 µm (1.5 mil) 50 µm (1.8 mil)
Unexposed Color in Yellow Light:	Blue
Exposed Color in Daylight:	Dark blue
Exposed Color in Yellow light:	Dark blue
Print-Out (Phototropic) Image:	Strong
Contrast to Copper:	Good
Odor:	Low

SAFE HANDLING

Note safety and industrial hygiene precautions**.** Consult the Safety Data Sheet (SDS) of any chemical used. SDS's for Riston® dry film photo-resists are available.

This Data Sheet documents specific process information for Riston® DI3000. For more background on general Riston® processing sees the General Processing Guide.

COPPER SURFACES AND SURFACE PREPARATION

Brush Pumice:
3F or 4F grade, fused, 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, 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 (Al_2O_3):
Follow vendor recommendations.

Compressed Pad Brushing:
500 grit; 7–9 mm (1/4–3/8") brush foot print; high pressure (8–10 bar) final rinse (pH 6–8).

Bristle Brushing
500 grit; 7–9 mm (1/4–3/8") brush foot print; 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
- R_a: 0.10–0.30 µm R_z: 2–3 µm

To remove antitarnish 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 Copper

Alkaline Spray Cleaner (e.g. VersaCLEAN® 415) for removal of organic contaminants followed by a spray microetchant (e.g. SureETCH® 550) 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 after microetching from the copper surface, an acid rinse or efficient water spray rinsing have been employed successfully. In-line systems for prelamination cleaning may not require an antitarnish treatment after chemical preclean to preserve the cleaned surface. Non-in-line systems with hold times of several hours will require antitarnish. For antitarnish selection: see "Electroless Copper with Antitarnish".

Electrochemically Cleaned 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 trace organics and chromates. After a rinse, a microetch removes about 0.8 µm (30 microinches) of copper. Following a second rinse an antitarnish may be applied.

Double-Treated Copper Surfaces

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

LAMINATION

Lamination Conditions DuPont HRL-24

• Pre-Heat:	Optional
• Roll Temperature:	115 ± 5 °C (239 ± 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

Post-Lamination Hold Time

- Panels may be exposed immediately after lamination; however, allow enough time for panels to cool to room temperature before lamination (about 5–15 minutes depends on panel thickness; use accumulator in in-line systems).
- Minimize hold time for best tenting performance.
- Maximum hold time (guidelines): Lamination: up to 2 days
  Hold times should be determined empirically based on the temperature and relative humidity of the storage area.

Note:
- When not laminating, cover film-rolls with black/opaque plastic at all time
- Guideline: strip within 5 days after lamination.

Laminator Conditions DuPont ASL-24 / Yieldmaster® Laminator

• Seal Bar Temp.:	70 ± 15 °C (168 ± 27 °F)
• Lam. Roll Pressure:	3.0–5.0 bar (43–72 psig)
• Lamination Temp. :	105 ± 5 °C (220 ± 9 °F)
• Seal Time:	2–4 seconds
• Seal Bar Pressure:	3.5–4.5 bar (50–65 psig)
• Lamination Speed:	1.5–3 M/min (5–10 ft/min)

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

Panel Handling/Racking/ Stacking

Preferred: Vertical racking in slotted racks
Less desirable: Stacking

To minimize adverse effects: stack on edge vertically after cooling; avoid dust and dirt trapping between panels; insert unlaminated panel between stack support and first laminated panel to protect laminated panel. Unlaminated support panel should be at least as big as the laminated panels. Thin flexible innerlayers usually cannot be racked.

Preferred techniques: hanging panels vertically or stacking on edge after cool down. If innerlayers are stacked horizontally in trays, the stack height should be limited especially for panels with thin photoresist and fine circuitry.

PERFORMANCE ON FLEXIBLE SUBSTRATES

DI3000 can be used successfully on thin core laminate and flexible substrates with the removal of antitarnish before dry film lamination.

EXPOSURE

Resolution (Lines & Spaces)

- In Optimized Production Environment by Paragon 8800Hi and 3650HH with good development and rinse control): 32 µm (1.25 mil) L/S for 38 µm resist

Exposure Energy vs "Steps Held" For Recommended Exposure Range

DI3000	25 µm	30 µm	38 µm	50 µm
RST-25	9-12	9-12	9-12	9-12
355-nm	11-15 mJ	12-18 mJ	15-21 mJ	16-24 mJ
405-nm	12-17 mJ	14-20 mJ	16-22 mJ	18-25 mJ

- Steps held can vary by ±2 RST depending on the development breakpoint used.
- Energy is measured by Paragon 8800Hi & 3650HH

DEVELOPMENT

Chemistries/Make-up

- **Sodium carbonate, anhydrous, (soda ash), Na_2CO_3**
  Working solution: 0.85 wt%.
- **Sodium carbonate, monohydrate; $Na_2CO_3 \bullet H_2O$**
  Working solution: 1.00 wt%.
- **Potassium carbonate (potash; K_2CO_3)**
  For make up use either potassium carbonate powder, i.e. anhydrous (potash) K_2CO_3 or a liquid concentrate such as DuPont D-4000 developer (40% concentrate).
  Working solution: 1.0 wt%.

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

- Na_2CO_3: kg Na_2CO_3 = wt% × sump vol liters × 0.01
  lb Na_2CO_3 = wt% × sump vol gallons × 0.083
- D-4000: liters D-4000 = wt% × sump vol liters
- K_2CO_3: kg K_2CO_3 = wt% × sump vol liters × 0.01
  lb K_2CO_3 = wt % x sump vol gallons × 0.083

Control Test:

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

wt% = N × mL HCl × FW ÷ 20 × mL Sample
(N = acid normality; FW = formula weight)
FW of Na_2CO_3 = 106
FW of $Na_2CO_3 \bullet H_2O$ = 124
FW of K_2CO_3 = 138

Defoamers

The need for defoamer and the amount required are dependent on water quality, carbonate purity, photoresist loading, and equipment design. If required, add 0.80 mL/L (3 mL/gallon) of FoamFREE™ 940, or equivalent 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: 1.4–2.1bar (20–30 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_2CO_3: 0.7–1.2 wt%; 0.85 wt% preferred
  $Na_2CO_3 \bullet H_2O$: 0.8–1.3 wt%; 1.0 wt% preferred
  K_2CO_3: 0.8–1.2 wt%; 1.0 wt% preferred
- Temperature: 27–35 °C (80–95 °F); 30 °C (85 °F) preferred

Dwell Time

- Breakpoint: 40–60% (50% preferred)
- Time in Developer (Dwell Time), at 1.4 bar (20 psig) spray pressure, 50% breakpoint. 30°C, fresh developer solution at recommended carbonate concentrations
  - 30 μm: 42 seconds
  - 38 μm: 52 seconds
  - 50 μm: 66 seconds

NOTE: Total time in developer = Time to clean divided by Breakpoint

- Time to Clean (time in developer to wash off unexposed resist, TTC):

Data below is from DuPont Lab evaluation result:

DI3000	25 um	30 μm	38 μm	50 μm
TTC (sec)	18	21	26	33

- Shorter times to clean are achieved at higher temperatures and higher pressures.
- If developer conveyor speed is too fast to match with other in-line equipment:
  1) lower soda ash concentration down as far as 0.5wt%.
  2) Consider lowering temperature.
  3) Plug spray manifolds near the entrance of developer

Resist Loading

Resist loading : 0–0.4 mil-m^2/L (0–12 mil-ft^2/gal)

Note: this range gives a fairly constant time to clean; lower loadings result in shorter time to clean; higher loadings increase the time to clean.

Developer Solution pH Response to Resist Loading for Riston® DI3000

pH	mil·M^2/L
11.34	0.000
11	0.036
11.07	0.073
10.94	0.109
10.84	0.145
10.77	0.182
10.7	0.218
10.63	0.255
10.57	0.291

Rinsing & Drying Recommendations

- Rinse water: hard water (150–250 ppm $CaCO_3$ 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 acid rinse, followed by a water rinse.
- Rinse temperature: 15–25 °C (60–80 °F)
- Rinse spray pressure: 1.4–2.1 bar (20–30 psig). Use high impact , direct-fan nozzles.
- Effective Rinse Length: 1/3–1/2 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 0.2 mil-m^2/L (8 mil-ft^2/gal), activate addition of fresh developer at pH 10.5; stop addition when pH 10.7 is reached.

Hold Time after Development before etching

0-5 days

Note: minimize white light exposure during post development hold to prevent film embrittlement and long stripping time.

ETCHING

- Riston® DI3000 resists are compatible with most acid etchants, e.g. cupric chloride (free HCl normality ≤ 3.0 N), H_2O_2/H_2SO_4, and ferric chloride.

PLATING

- Riston® DI3000 resists are compatible with most plating chemicals; DI3000 has very strong resistance to lifting/under plating and organic leaching. Please contact a DuPont technical representative for further details.

STRIPPING

Aqueous Caustic (NaOH or KOH) Conveyorized Stripping

• Stripper Dwell Times (seconds) at 50 °C, 1.7 kg/cm^2 (30 psig), over recommended exposure range:

Stripping Dwell Times	25 µm	30 µm	38 µm	50 µm
	35–44 s	48–55 s	65–71 s	109–118 s

Note:
• Dwell Time = 2 × Time to strip resist
• High caustic concentrations produce larger skin sizes and higher loading capabilities.
• KOH generally produces smaller stripping sizes than NaOH.

• Particle Size at 3.0% NaOH: Sheet
• Solubility of Stripped Particles: Very Low

• Stripping time increases after plating and depends on contact area.
• 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.

Defoamers

Additives for foam control may not be required depending on equipment design and operation. However, if defoamer is needed, use DuPont FoamFREE™ 940 at 0.8 mL/L (3 mL/gallon) for resist loadings up to 0.6 mil-m^2/L (25 mil-ft^2/gal).

Controls/ Solution Maintenance:

• Preferred: Continuous replenishment (feed & bleed) using board count.
Maintain resist loading at ≤ 0.4 mil-m^2/L (≤ 15 mil-square feet/gallon).
• Batch: up to 0.5 mil-m^2/L (20 mil-square feet/gallon).
• 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 stripper skins immediately after they were generated, before entering recirculation pumps, and they feature continuous removal of skins from the stripper solution.

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, to minimize chemical attack on tin or tin/lead, or to reduce copper oxidation, e.g. to facilitate AOI.

Reworking Panels for Re-use

Stripped panels may contain organic residues from photoresist or defoamers. After stripping, regenerate a fresh copper surface as follows, before mechanically cleaning the panels:

• Soak for three minutes in a hot soak cleaner at the recommended temperature.
• Rinse thoroughly.
• Etch 0.13 µm (5 microinches) of copper if panels are deeply oxidized.
• Rinse thoroughly.

• Dip in 5–10% sulfuric acid.
• Rinse thoroughly
• Dry

SAFE LIGHTING

• Protect photoresist through lamination and development steps from UV radiation and visible light up to 450 nm by use of yellow, amber or gold fluorescent “safe lights”.
• High intensity (up to 70 footcandles) yellow “safe light” causes a change in steps held and should be avoided.
• All films especially partially used rolls must be kept with black-plastic at all times. Similarly, it is recommended that laminated panels on hold for prolong periods should be covered.

WASTE DISPOSAL

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