PHOTEC PH-2000 SERIES

Fully aqueous dry film photoresists

GENERAL

The Hitachi Chemical Photec PH-2000 Series is a completely new platform fully aqueous dry film photoresist which can be used for production of high circuit density printed wiring boards. These new highly photosensitive films are developed for tenting, etching and pattern plating processes. The Photec PH-2000 Series will improve production yields due to it's excellent plating resistance, tenting properties and excellent resolution and adhesion characteristics. This film is available in 3 thicknesses i.e. 30, 40 and 50 µm.

FEATURES

The features allow high density circuits to be produced with high first pass yield.

- ★ Excellent adhesion and conforming properties enabling fine line circuitries.
- ★ High photosensitivity and fast in exposure providing high throughput.
- ★ Good image contrast after exposure allows ease of inspection.
- ★ Fully compatible with electroplating processes.
- ★ Good tenting properties.
- ★ Reduced sludging in the development chamber resulting in less down time for maintenance.

PHYSICAL CHARACTERISTICS

Photec	Thickness (µm)	Length (m)
PH-2030	30	150 or 300
PH-2040	40	150 or 300
PH-2050	50	150 or 300

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PROCESS SEQUENCE PH-2030

PROCESS	PROCESS DESCRIPTION		TYPICAL PROCESS CONDITIONS	REMARKS
			PH-2030	
Substrate Pre-treatment	Substrate Preparation		Chemical clean or Pumice Brush	See Substrate Surface Preparation Section Surface roughness R_a 0.2 - 0.4 microns R_{max} 2.5 - 3.0 microns
	Water spray. Water temp °C		RT	
	Water spray time (sec)		10-30	
	Water spray pressure (kgf/cm^2)		1.5-2.5	
	Drying		50 - 80°C	
Lamination	Suitable temperature range °C		110 ± 10	Substrate exit temperature from laminator 45-55°C desirable. Pressure 3.0-5.0 kgf/cm^2
	Lamination speed (m/min)		1.0-3.0 m/min	
Holding	Room temp 23 ± 2°C (60 ± 10% RH)		Over 5 min	Ensure substrate is at room temperature before proceeding, yellow lamp condition
Exposure	41 step tablet (steps hold)		23± 3	1. Exposure light source by high voltage mercury lamp 2. Obtained by Hitachi 41 step tablet. 3. Film changes its colour from light blue to dark blue on exposure.
	mJ/cm^2	Non collimated	40	
		Collimated	45	
Holding	Room temp 23 ± 2°C (60 ± 10% RH)		Over 5 min	
Development	Developer spray	Developer	Na_2CO_3 aqueous solution	1. Change developer in the light of the following guide Thickness: 30 µm Area (m^2) Developed by 1 litre of developer: 0,33
		Developer concentration(%)	1.0 + 0.3 Anhydrous – 0.1 Na_2CO_3	
		Developer temp (°C)	30 ± 2	
		Developer time (sec) (MDT)	16	
		Total development time	1,5-2,0 x MDT	
	Water Spray 1	Spray pressure (kgf/cm^2)	1.2-2.0	
		Water temp (°C)	RT- 30°C	
		Water spray time (sec)	15-40	
				2. Addition of defoaming agent is desirable
	Water Spray 2	Water temp (°C)	RT - 30°C	3. To avoid lifting of resist from substrate edges, it is essential to leave unexposed areas as edges
		Spray time (sec)	30-60	
		Spray pressure (kgf/cm^2)	1.2-2.0	4. See Development Section.
	Air shower (sec) (30 – 50°C)		10-20	MDT = Minimum Development Time
Stripping	Stripper Spray	Stripper	Sodium Hydroxide or Potassium Hydroxide Aqueous solution	See stripping section. Thickness: 30 µm Area (m^2) stripped by 1 litre of stripper: 0.67
		Stripper concentration (Wt%)	2.5±0.5	
		Stripper temp (°C)	50±5	
		Stripper time (sec) MST	23	
		Total stripping time	1,5-2,0 x MST	
	Water Spray 1	Spray pressure (kgf/cm^2)	Over 1	
		Water temp (°C)	RT	
		Water spray time (sec)	20-30	1. For proprietary strippers: see Enthone TDS
		Spray pressure (kgf/cm^2)	over 1	
	Water Spray 2	Water temp (°C)	Room temp (10-30)	2. Addition of defoaming agent may be required MST = Minimum stripping time
		Water spray time (sec)	30-60	
		Spray pressure (kgf/cm^2)	over 1	

PROCESS SEQUENCE H-2040

PROCESS		PROCESS DESCRIPTION	TYPICAL PROCESS CONDITIONS	REMARKS
			PH-2040	
Substrate Pre-treatment		Substrate Preparation	Chemical clean or Pumice Brush	See Substrate Surface Preparation Section Surface roughness R_a 0.2 - 0.4 microns R_{max} 2.5 - 3.0 microns
		Water spray. Water temp °C	RT	
		Water spray time (sec)	10-30	
		Water spray pressure (kgf/cm^2)	1.5-2.5	
		Drying	50 –80°C	
Lamination		Suitable temperature range °C	110 ± 10	Substrate exit temperature from laminator 45-55°C desirable.
		Lamination speed (m/min)	1.0-3.0 m/min	Pressure 3.0-5.0 kgf/cm^2
Holding		Room temp 23 ± 2°C (60 ± 10% RH)	Over 5 min	Ensure substrate is at room temperature before proceeding, yellow lamp condition
Exposure		41 step tablet (steps hold)	23± 3	1. Exposure light source by high voltage mercury lamp 2. Obtained by Hitachi 41 step tablet. 3. Film changes its colour from light blue to dark blue on exposure.
	mJ/cm^2	Non collimated	40	
		Collimated	45	
Holding		Room temp 23 ± 2°C (60 ± 10% RH)	Over 5 min	
Development	Developer spray	Developer	Na_2CO_3 aqueous solution	1. Change developer in the light of the following guide
		Developer concentration (%)	1.0 + 0.3 Anhydrous - 0.1 Na_2CO_3	Thickness: 40 µm
		Developer temp (°C)	30 ± 2	Area (m^2) Developed by 1 litre of developer: 0.25
		Developer time (sec) (MDT)	23	
		Total development time	1,5-2,0 x MDT	
	Water Spray 1	Spray pressure (kgf/cm^2)	1.2-2.0	
		Water temp (°C)	RT- 30°C	
		Water spray time (sec)	15-40	
				2. Addition of defoaming agent is desirable
	Water Spray 2	Water temp (°C)	RT – 30°C	3. To avoid lifting of resist from substrate edges, it is essential to leave unexposed areas as edges
		Spray time (sec)	30-60	
		Spray pressure (kgf/cm^2)	1.2-2.0	4. See Development Section.
		Air shower (sec) (30-50°C)	10-20	MDT = Minimum Development Time
Stripping	Stripper Spray	Stripper	Sodium Hydroxide or Potassium Hydroxide Aqueous solution	See stripping section.
		Stripper concentration (Wt%)	2.5±0.5	Thickness: 40 µm
		Stripper temp (°C)	50±5	Area (m^2) stripped by 1 litre of stripper: 0.5
		Stripper time (sec) MST	45	
		Total stripping time	1,5-2,0 x MST	
	Water Spray 1	Spray pressure (kgf/cm^2)	Over 1	
		Water temp (°C)	RT	
		Water spray time (sec)	20 – 30	1. For proprietary strippers: see Enthone TDS
		Spray pressure (kgf/cm^2)	over 1	
	Water Spray 2	Water temp (°C)	Room temp (10-30)	2. Addition of defoaming agent may be required
		Water spray time (sec)	30-60	MST = Minimum stripping time
		Spray pressure (kgf/cm^2)	over 1	

PROCESS SEQUENCE H-2050

PROCESS	PROCESS DESCRIPTION		TYPICAL PROCESS CONDITIONS	REMARKS
			PH-2050	
Substrate Pre-treatment	Substrate Preparation		Chemical clean or Pumice Brush	See Substrate Surface Preparation Section Surface roughness R_a 0.2 - 0.4 microns R_{max} 2.5 - 3.0 microns
	Water spray. Water temp °C		RT	
	Water spray time (sec)		10-30	
	Water spray pressure (kgf/cm^2)		1.5-2.5	
	Drying		50 – 80°C	
Lamination	Suitable temperature range °C		110 ± 10	Substrate exit temperature from laminator 40-50°C desirable.
	Lamination speed (m/min)		1.5-3.0 m/min	Pressure 3.0-5.0 kgf/cm^2
Holding	Room temp 23 ± 2°C (60 ± 10% RH)		Over 5 min	Ensure substrate is at room temperature before proceeding, yellow lamp condition
Exposure	41 step tablet (steps hold)		23± 3	1. Exposure light source by high voltage mercury lamp 2. Obtained by Hitachi 41 step tablet. 3. Film changes its colour from light blue to dark blue on exposure.
	mJ/cm^2	Non collimated	45	
		Collimated	51	
Holding	Room temp 23 ± 2°C (60 ± 10% RH)		Over 5 min	
Development	Developer spray	Developer	Na_2CO_3 aqueous solution	1. Change developer in the light of the following guide Thickness: 50 µm Area (m^2) Developed by 1 litre of developer: 0.20
		Developer concentration (%)	1.0±0.3 Anhydrous Na_2CO_3	
		Developer temp (°C)	30 ± 2	
		Developer time (sec) (MDT)	30	
		Total development time	1.7-2.3 x MDT	
	Water Spray 1	Spray pressure (kgf/cm^2)	1.2-2.0	
		Water temp (°C)	RT – 30°C	
		Water spray time (sec)	15-40	
				2. Addition of defoaming agent is desirable
	Water Spray 2	Water temp (°C)	RT - 30°C	3. To avoid lifting of resist from substrate edges, it is essential to leave unexposed areas as edges
		Spray time (sec)	30-60	
		Spray pressure (kgf/cm^2)	1.2-2.0	4. See Development Section.
	Air shower (sec) (30-50°C)		10-20	MDT = Minimum Development Time
Stripping	Stripper Spray	Stripper	Sodium Hydroxide or Potassium Hydroxide Aqueous solution	See stripping section. Thickness: 50 µm Area (m^2) stripped by 1 litre of stripper: 0.4
		Stripper concentration (Wt%)	2.5±0.5	
		Stripper temp (°C)	50±5	
		Stripper time (sec) MST	62	
		Total stripping time	1,5-2,0 x MST	
	Water Spray 1	Spray pressure (kgf/cm^2)	Over 1	
		Water temp (°C)	RT	1. For poprietary stripper: see Enthone TDS
		Water spray time (sec)	20 - 30	2. In case of Sn plating it is recommended to strip at lower temperatures
		Spray pressure (kgf/cm^2)	over 1	
	Water Spray 2	Water temp (°C)	Room temp (10-30)	3. Addition of defoaming agent may be required
		Water spray time (sec)	30-60	MST = Minimum stripping time
		Spray pressure (kgf/cm^2)	over 1	

GENERAL CHARACTERISTICS

Characteristics			PH-2030	PH-2040	PH-2050
Application			Etching	Plating Etching Tenting	Plating Etching Tenting
Exposure	Sensitivity (mJ/cm^2, ST= 23/41)	Non collimated light *1	40	40	45
		Collimated light *1	45	45	51
	Recommended exposure energy (mJ/cm^2)	Non collimated light *1	28-56	28-56	32-64
		Collimated light *1	28-56	32-64	36-72
	Recommended ST (x/41 : 41-step tablet)		23 ± 3	23.0 ± 3.0	23±3
Development	Minimum developing time (MD) (sec)	1.0 wt%Na_2CO_3/30°C	16	23	30
	Foam height of developer (mm) *2	No defoamer	65	50	65
	Scum occurrence (x/4) *2	No defoamer	4	4	4
	Easiness of sludge removal (x/4) *2	No defoamer	4	4	4
Non-collimated light exposure *1	Adhesion : RP-4 (µm) *3 L/S=n/400	ST=17/41	22	30	35
		ST=20/41	20	25	30
		ST=23/41	15	20	25
		ST=26/41	15	18	22
	Resolution: RP-2 (µm) *3 L/S=400/n	ST=17/41	30	35	40
		ST=20/41	35	40	45
		ST=23/41	40	45	50
		ST=26/41	45	50	60
Collimated light exposure *1	Adhesion: RP-4 (µm) *3 L/S=n/400	ST=17/41	27	35	40
		ST=20/41	25	30	35
		ST=23/41	20	25	25
		ST=26/41	18	22	32
	Resolution: RP-2 (µm) *3 L/S=400/n	ST=17/41	<30	<30	30
		ST=20/41	30	30	35
		ST=23/41	35	35	40
		ST=26/41	40	40	45
Imaging property (ST=23/41, 1 min) *4			25	30	35
Plating resistance *5 (underplating; x/4)		Standard condition	-	4	4
		Severe condition	-	4	4
Breakage ratio of round hole (%, Ø 3,5,7 mm) *6		ST=17/41, MDx4	-	0	0
Breakage ratio of oval hole (%, Ø 3,5,7 mm) *6		ST=17/41, MDx4	-	6	3
Stripping *7 3.0 wt% NaOH/50°C, ST=23/41		Stripping time (sec)	23	45	62
		Size of stripped flake (mm)	20	15	15

*1 Non-collimated light exposure: HMW-201GX (ORC Manufacturing Co. Ltd.)
Collimated light exposure: EXM-1201 (ORC Manufacturing Co. Ltd.)

*2 (1) 0.39 m^2/l (severe condition : 0.26 m^2/l (recommended maximum resist loading amount) x 1.5) of dry film was dissolved in 1.0wt% Na_2CO_3 aqueous solution.
(2) The Na_2CO_3 aqueous solution was circulated in a pilot scale development machine for 90 minutes at 30°C. Then the foam height was measured. Scum occurrence was evaluated in the following (larger value shows less contamination to development machine):

Scum occurrence

Level 4	No scum is observed
Level 3	A little scum is observed
Level 2	Some scum is observed
Level 1	Lots of scum is observed

(3) After the evaluation of scum property, that solution was replaced into a polyethylene bottle and left for 7 days. After this period the bottle was shaken 10 times, the precipitation (sludge) on the bottom of the bottle was observed. Ease of sludge removal was evaluated . (larger figure shows less contamination to the development machine):

Easiness of sludge removal

Level 4	No sludge is observed
Level 3	A little sludge is observed
Level 2	Observed
Level 1	Lots of sludge is observed

*3 (1) Hitachi test pattern No. 3 (RP-4), G-2 (RP-2)
Adhesion: RP-4 (μm): L/S=n/400
Resolution: RP-2 (μm), L/S=400/n

(2) Development time : MD x 2.0

*4 The numerical value shows contrast between exposed (ST=23/41) and unexposed parts after 1 minute. The higher value demonstrates higher contrast.

*5 Table 2 shows the plating conditions. The plating test was evaluated in the following:

Level 4	No Sn underplating
Level 3	≦ 20 μm of Sn underplating
Level 2	20-100 μm of Sn underplating
Level 1	> 100 μm of Sn underplating

Table 2: Plating conditions: ( ) means severe conditions

Process	**Conditons**
Board	MCL board
Pre-treatment	# 600 buffing-grain polish (10 vol% H_2SO_4 aq., 23°C, 1 min)
Pre-heat	80°C, 10 min. (no pre-heating) The temperature of the substrate surface: 50°C (r.t.)
Lamination	Laminator: HLM-3000 (Hitachi) Roll temperature: 110 ±10°C Roll pressure: 0.4 Mpa Speed: 2.0 m/min
Holding	23°C, 10 min
Exposure	Non-collimated light exposure: HMW-201GX (ORC), 5 kw Exposure energy: ST=23/41 (ST= 20/41)
Holding	23°C, 10 min
Development	1 wt% Na_2CO_3 aq., 30°C, 0.18 Mpa development time: MD x 2.0
Water rinsing	0.2 Mpa
Cleaning	12.5 vol% H_2SO_4 aq., 23°C, 1 min.
Copper-sulfate plating	Standard Acid Copper Bath * 23°C, 2.5 A/dm^2, 40 min. (3.0 A/dm^2, 40 min)
Water rinsing	1 min, 2 tanks
Acid dipping	10 vol% H_2SO_4 aq., 23°C, 1 min
Tin-sulfate plating	Standard process 23°C, 1.5 A/dm^2, 15 min
Water rinsing	1 min., 3 tubs

* Tested Cupracid HL, also Enthone Cuprostar compatible

*6 Exposure energy : ST = 17/41 (Non-collimated light exposure: HMW-201GX (ORC Manufacturing Co., Ltd.
Development time: MD x 4
Round hole: Ø 7 mm, Ø 5mm, Ø 3 mm, each 86, Oval hole: Ø 7 mm, Ø 5 mm, Ø 3 mm, each 12

*7 Dipping test: 3.0 wt% NaOH aqueous solution, 50°C
Exposure energy: ST = 23/41
After stirring for 30 seconds, the size of stripped film was observed.

SUBSTRATE SURFACE PREPARATION

Electroless Copper Surfaces

It is essential that all chemical copper residues are removed from the surfaces and holes and that the surfaces are neutralised prior to the final rinse and drying operation.

The sequence of operation after electroless copper is:-

*	Drag out rinse	To remove bulk of copper solution.
*	Counter flow rinse	Air agitated two stage rinse
*	Warm water rinse	2-3 minutes at 50-60°C.
*	Neutralisation of surfaces	5 Vol% Sulphuric acid
*	Counter flow rinse	Air agitated two stage rinse
*	Drying	By hot air blowing and/or oven drying at 60-70°C. Surfaces should be uniform in colour and stain free. Holes should be absolutely free of moisture.

Photec PH-2000 Series can be laminated directly onto unscrubbed electroless copper surfaces if the previous actions have been performed.

Any anti-tarnish applied to the electroless copper surfaces should be checked for compatibility with the Photec prior to use.

ENTEK™ Cu 56 is a suitable anti-tarnish if used at 0.25%.

If the electroless copper surfaces are to be scrubbed before lamination see guidelines under pre-treatment for base copper laminate.

BASE COPPER LAMINATE

Electrolytically deposited copper

To prepare these surfaces the following pre-treatments have been found suitable:

* **BRUSH PUMICE**

The pumice should be the fused type with particle size 3F or 4F
or pumice grade 3 ON or 3 OB.
Concentration 15-20% vol/vol.
Brush footprint 9-12 mm

The equipment for ‘fines’ removal and replenishment should be used according to the supplier recommendations.

After the pumice operation the water rinse stage should be:

Spray water rinse, water temperature 8-20°C, 10-30 seconds.
Spray pressure - 1,4-2,0 Bar
Final water rinse, high pressure (10 Bar) pH 5-8.

* **JET PUMICE**

The pumice used should be of the unfused type.
Other parameters should be the same as for BRUSH PUMICE.

* **BRISTLE BRUSHING**

Scotch-Brite VF-SF (Grit 320-800)
Brush footprint 9-12 mm
Water rinse, high pressure (8-10 Bar) pH 5-8.

NOTE

The combined use of Bristle Brushing and Pumice Brush produces an ideal surface for lamination.

Stacking of the boards after pre-treatment can cause scratches and/or dents.

To control pre-treatment

*	Water Break Test	Minimum 30 seconds
	R_a	0,2-0,4 microns
	R_{max}	2,5-3,0 microns

LAMINATION

Photec PH-2000 Series has excellent conformability characteristics which should be taken into account when using the resist for tenting applications.

Recommended lamination conditions are:-

Panel temperature prior to lamination	°C	35-40
Hot roller temperature	°C	110±10
Pressure	Bar	3.0-5.0
Lamination speed	m/min	1.0-3.0
Board exit temperature	°C	45-55

Panels should not be stacked together after lamination until room temperature is reached.

EXPOSURE

High pressure mercury vapour lamps with this peak spectral output are recommended.

Exposure time will depend on the equipment, intensity of illumination, age of lamps, temperature etc.

The determination of the correct exposure should be carried out using the HITACHI CHEMICAL 41 STEP exposure tablet.

Note: If a step density tablet is used, it is highly recommended to use a phototool.

VACUUM FRAME

For finer resolution the preferred contact mode is 'Hard Contact'. Check should be made for indication of good contact between the phototool and the substrate i.e. immovable Newton's Rings.

DEVELOPMENT

The development rate depends on the developer concentration, temperature and the spray equipment used.

Photec PH-2000 Series can be developed within the temperature range 28-32°C. It is essential to determine the correct development time for the temperature used.

The concentration of anhydrous Sodium Carbonate used for development is within the range 0.9 - 1.3 weight percent.

To determine the correct development time for each product proceed as follows:

Establish the minimum development time taken in the spray equipment, at the operation temperature, for a laminated but unexposed board to have the resist completely removed as it exits the development chamber.

The correct development time is 1.5 - 2.0 times this minimum development time.

An addition of Antifoam may be required. Antifoams containing water miscible organic solvents and those based on Siloxanes are NOT recommended. Please consult local Enthone engineer.

RESIST LOADING

The resist loading affects the resolution that can be achieved and the time of the development. For fine lines and spaces and optimum development time the resist loading in the development solution should be maintained between 0 – 0.33 m^2/l (30 µm), 0 – 0.25 m^2/l (40 µm) and 0 – 0.20 m^2/l (50µm) thick resist.

RINSING AND DRYING RECOMMENDATIONS

The rinse waters used after development should have a hardness of between 8° and 12° DIN (140-210 mg/litre $CaCO_3$). Temperature of the water should be between 8°C and 30°C.

If hard water is not available the first soft water rinse should be followed by a dilute Sulphuric Acid rinse followed by a water rinse.

Water rinse spray pressure 1,2-2,0 Bar.

The preferred effective water rinse chamber length is minimally 50% of the effective development chamber length.

For cleaning of Developing Equipment see separate bulletin on DEVELOPMENT EQUIPMENT MAINTENANCE.

PREPLATE CLEANING

Photec PH-2000 Series dry film resists can be used as an electroplating resist. When used as an electroplating resist the following preplate cleaning sequence is recommended:

Acid Cleaner	ENPLATE™ PC 455
Cold water rinse	
Copper Activation	ENPLATE AD 485
Cold water rinse	
Sulphuric acid 10% v/v	
Cold water rinse	
Acid copper	CUPROSTAR LP-1

or CUPROSTAR ST

STRIPPING

The Photec PH-2000 Series of resist can be stripped in either dilute alkali metal hydroxide solutions or proprietary strippers.

Stripping	
Potassium Hydroxide or Sodium Hydroxide	
Concentration WT%	2.5 ± 0.5
Temperature °C	50 ± 5
Minimum stripping time (secs)	
30 µm	23
40 µm	45
50 µm	62

The stripping time and stripped resist particle size depends upon equipment, temperature, solution flow rate and pressure etc.

ADDITIONAL NOTES

- The total stripping time is 1,5-2,0 times the minimum stripping time. Potassium Hydroxide generally produces smaller stripped flake size than Sodium Hydroxide.

- Rate of stripping can be increased by higher temperatures and by using higher impact spray nozzles.

- Antifoam may be required depending on Resist Loading, type of equipment etc.

- The recommended resist loading is in the range 0-0.67 m^2/l (30 µm), 0-0.50 m^2/ (40 µm) and 0-0.40 m^2/l (50 µm) thick resist.

- Proprietary strippers are used to increase speed of stripping, to enable a higher resist loading to be obtained to reduce attack on tin-lead deposits and to reduce oxidation of copper.

- Enthone range of resist strippers have been formulated to be effective stripping solutions for Photec dry films.

- Fumes evolved from the photoresist during lamination are classified as irritant. Ensure that the film is used in a well ventilated area. An exhaust system fitted to the laminator is recommended.

- After handling unexposed dry film or the polyester protective layer removed prior to development, wash the hands with soap and water.

- Direct contact with the unexposed photosensitive layer should be avoided to prevent skin irritations.

- Substrate preheating: too high preheat temperature for a long time may cause oxidation. This should be done for less than 10 min at 80°C or for less than 3 min. at 150°C. When the substrate surface temperature prior to lamination exceeds 70°C, the film thickness at a through-hole edge may become thinned and this may cause tenting defects.

- Holding after lamination and exposure: Hold panels by black sheets or under a yellow lamp. The maximum holding time in the latter case (under a yellow lamp) is 4 days. Development should be done within 4 days after lamination and in 3 days after exposure. Keep temperature ≤ 25°C and relative humidity 60 ± 10%. Piling up laminated substrates may cause the following defects:

- Resist may be polymerised by heat accumulation and may result in some residues after development.
- The film of the photosensitive layer at a through-hole edge may be thinned and could break the tent. When using for tenting, put the laminated substrates in a rack (vertically).
- Sandwiched dusts and foreign particles may thin the film of the photosensitive layer and could cause opens or short circuits.

- Stripping: Strip within one week after lamination.

- Dry film components in developer and stripper can be coagulated by neutralisation. The coagulated components can be separated from the aqueous solution by filter press method and centrifugal method. The separated aqueous solution will contribute to high COD and BOD values, therefore it has to be waste disposal treated in a proper way.

- Although colour of the Photec PH-2000 series could vary in time, this is within specification and will not affect the properties of the dry film.

STORAGE CONDITIONS

Long time storage temperature	5 – 18°C
Short time storage temperature (max 5 days)	15 – 20°C
% RH	35 – 57%

HANDLING AND SAFETY INSTRUCTIONS

For detailed information consult the material safety data sheets for this product.
Please read material safety data sheets carefully before using this product.

DISCLAIMER

All recommendations and suggestions in this bulletin concerning the use of our products are based upon tests and data believed to be reliable. Since the actual use by others is beyond our control, no guarantee expressed or implied, is made by Enthone, its subsidiaries of distributors, as to the effects of such use or results to be obtained, nor is any information to be construed as a recommendation to infringe any patent.

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