FLEX PHOTOIMAGE MASK
NPR-80/ID60

- Alkaline Developable Photoimagable Solder Mask for Flex PCBs -

Product system

Main resin:

NPR-80 /ID60 (Green color)

Hardener:

HARDENER PF-10 /ID60

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1. General

FLEX PHOTOIMAGE MASK "NPR-80/ID60" is the flame retarded solder resist with the halogen compound. The features of this product are flame retardancy, excellent reliability and low tackiness. It is alkaline developable two component ink coated the screen printing. It is developed for a high density flexible printed circuit boards (FPCs).

2. Special Features

- **UL 94 V-0**.
- Low tackiness, the contact exposure is possible.
- Good bending resistance, real plane flexible circuit is always expectable.
- Stable in electroless Ni/Au plating operation, good plating results is always expectable.
- Excellent characteristic of PCT, HHBT.
- By the way of photoimaging, a superior fine line, fine pitch resolution is expectable.

3. Direction to use

i) Preparation of the ink	Mix the main resins "**NPR-80/ID60**" with the specified hardener "**PF-10/ID60**" by the instructed ratio, and stir thoroughly before use. Hold for at least 30 minutes before put into application. * Use as supplied, without dilution as possible. Dilution might cause a drop of coated-film thickness on the edge of the circuit. Employ the specified thinner SOLVENT #8500 for the purpose, if a dilution is absolutely required.

Specifications of the ink

	NPR-80/ ID60	**HARDENER PF-10/ ID60**
Packaging size	720 g	280 g
Ratio of Main Resins / Hardener	100 g / 39 g	
Form	Green - colored paste	Pale brown - colored paste
Flash point (sealed cup, Seta method)	82 deg. C	72 deg. C
Specific Gravity (25 deg. C)	1.2	1.2
Antifoaming agent	Silicon type (Silicon polymer)	

Viscosity of mixture (25 deg. C, Viscotester VT-04, No.2 rotor)	200～240 dPa･s
Thixotropic Index of mixture (25 deg. C, Brookfield HBT)	1.6～2.0
Solid content of mixture (at 130 deg. C for 1hour in a box oven)	about 77 wt%
Shelf life (Store at 25 deg. C)	about 90 days
Pot life (Store at 25 deg. C	about 3 days
Specified thinner for NPR-80 series	Solvent #8500 (made by Nippon Polytech Corp.)

ii) Coating	Screen printing application is recommended as for the coating method. A 100 to 150 meshes polyester-based screen is recommended. Thickness of solder mask after final curing is recommended 15 to 25 μm on the circuit. In case the film thickness is thick excessively, the tackiness, flexibility and developability might fall off.
iii) Holding	Hold in a clean area for 10 to 30 minutes at room temperature to antifoam the coating ink.
iv) Drying	[Recommendable drying conditions is as follows] 70 deg. C, 30-60 minutes or 75 deg. C, 30-45 minutes or 80 deg. C, 30minutes * The limitations of drying conditions are at 70 deg. C for 75 minutes, 75 deg. C for 60 minutes, 80 deg. C for 45 minutes. Do not exceed the said limitation, which might cause a poor developability of coated-film itself.
v) Cooling	Hold in a cool area, or use a cooling instrument, to cool down the substrate to the room temperature.

vi) Exposure	[Recommendable exposure conditions is as follows] 8 to 10 steps of 21steps tablet[3)] on Cu film is recommended for exposure purpose. The exposure energy is 400 to 600 mJ/cm^2 at scattered light with 7kw metal halide lamp. Do not be short of exposure energy, which might cause the reliability of cured-film itself. In case of excess exposure energy, the halation might cause. The steps are different by the preparation condition of test pieces. The steps were obtained by doing the conditions of Clause 14. 3) 21steps tablet; Photec 21 step density tablet made by Hitachi Chemical Co., Ltd.
vii) Holding	Hold in a clean area for 10 to 30 minutes at room temperature to become stable the photosensitivity.
viii) Developing	[Recommendable developing conditions is as follows] Solution; 1.0 wt% - Na_2CO_3 aqueous solution Solution temperature; 30 deg. C Spray pressure; 0.1 to 0.2 MPa Developing time; 60 to 90 seconds Do not exceed the stated limitation, which might cause the poor flexibility and the reliability of cured-film itself.
ix) Rinsing	[Recommendable rinsing conditions is as follows] Solution; City water and ion exchanged water Rinsing process; 1st step- City water, 2nd step – ion exchanged water Solution temperature; 30 deg. C Spray pressure; 0.1 to 0.2 MPa Rinsing time; 60 to 90 seconds In the case that the rinsing is not sufficient, the flexibility and reliability of the cured film might fall off. Wash it sufficiently by using city water and ion exchanged water.
x) Thermal curing	Perform the curing in 150 deg. C for 30 to 60 minutes in a box oven. * Post-cure; Use UV conveyer, in case of plating

4. Pot Life

Time after mix	0.5 hours	1 day	2 days	3 days	4 days	5 days
Viscosity [4] (dPa·s, 25 deg. C)	210	230	240	240	240	250
drying conditions	Developability					
80 deg. C- 30 minutes	No residue	No residue	No residue	No residue	No residue	No residue
- 45 minutes	No residue	No residue	No residue	No residue	No residue	No residue
- 60 minutes	No residue	No residue	No residue	No residue	Residue	Residue
- 75 minutes	Residue	Residue	Residue	Residue	Residue	Residue
- 90 minutes	Residue	Residue	Residue	Residue	Residue	Residue

4) 25 deg. C, Viscotester VT-04, No.2 rotor

5. Pre-drying condition vs. Developability

Pre-dry conditions	70deg. C	75deg. C	80deg. C	85deg. C	90deg. C
30 minutes	No residue	No residue	No residue	No residue	Residue
45 minutes	No residue	No residue	No residue	Residue	Residue
60 minutes	No residue	No residue	No residue	Residue	Residue
75 minutes	No residue	No residue	Residue	Residue	Residue
90 minutes	No residue	Residue	Residue	Residue	Residue

6. Developability after coating [5]

Pre-dry conditions	Right after coating	1 day	2 days	3 days
80deg. C- 30 minutes	No residue	No residue	No residue	No residue
- 45 minutes	No residue	No residue	No residue	Residue
- 60 minutes	No residue	No residue	Residue	Residue
- 75 minutes	Residue	Residue	Residue	Residue
- 90 minutes	Residue	Residue	Residue	Residue

5) Store in a clean area at room temperature after UV exposure.

7. Physical Properties

Test items		Typical value	Reference data
Photosensitivity on rolled Cu substrate		8 – 9	Hitachi 21 step tablet [3)]
		9 – 10	Stouffer 21 step guide [6)]
		26 – 31	Stouffer 41 step guide [7)]
Resolution (μm) on rolled Cu substrate (Line / Space)		40 / 40	Hitachi Photec G2 test pattern [8)]
		50 / 300	Hitachi Photec No.1 test pattern [9)]
Pencil hardness on rolled Copper		5H	JIS K 5600, cohesive fracture
		2H	JIS K 5600, plastic deformation
Adhesive strength on rolled Copper	Cross-cut test	Class 0	JIS K 5600, Tape peeling
	Checker flag type	Pass	TM 2.4.28.1 of IPC-TM-650
Heat soldering resistance on rolled Copper		Pass 2 cycles	RMA flux applied, 260 deg. C, 5 seconds
Flexibility on PI film (Kapton 100H)		Pass	Bending at diameter of 0.2mm
Water absorption (%) (film thickness; about 60 μm)		No data	23 deg. C, 24 H, dipping in H_2O
		No data	85 deg. C, 85 %Rh, 4 H
Contact angle	H_2O	80°	JIS R3257 - Sessile drop method
Tg (deg. C)		70	TMA method, Tensile mode Load-5gf, Rate-5 deg. C/min. Width-3mm, Length-20mm
CTE (/deg. C)	Before Tg (10 to 40 deg. C)	7×10^{-5}	
	Immediately after Tg (75 to 81 deg. C)	5×10^{-3}	
	After Tg (110 to 140 deg. C)	7×10^{-5}	
Young's modulus (GPa)		3.2	1.0 mm/minutes
Tensile strength (MPa)		88	10.0 mm/minutes
Breakdown elongation (%)		2.3	10.0 mm/minutes

3) Hitachi 21 step tablet; Photec 21 step density tablet made by Hitachi Chemical Co., Ltd.

6) Stouffer 21 step guide; Stouffer 21 step sensitivity guide made by Stouffer Graphic Arts Equipment Co.

7) Stouffer 41 step guide; Transparent step wedge 41 steps by Stouffer Graphic Arts Equipment Co.

8) Resolution; Photec Test Pattern No. G2 negative film made by Hitachi Chemical Co., Ltd.

9) Resolution; Photec Test Pattern No. 1 negative film made by Hitachi Chemical Co., Ltd.

8. Flame retardancy

Flame retardancy	Cover-coat; 10μm	UL 94 V-0	Cover-coat / EPD / Cover-coat EPD; ESPANEX SC substrate, 25μm PI film only. (Nippon Steel Chemical)
	Cover-coat; 30μm	UL 94 V-0	

9. Resistance to solvent [11)]

Boiling water test on Cu film ;60 minutes		No peel off	Tape peeling test
Resistance to solvents on Cu film			
MEK	;30 minutes	No peel off	Tape peeling test after dipping at 23 deg. C
IPA (2-propanol)	;30 minutes	No peel off	
Methylene Chloride	;10 minutes	a slightly swelling	
Resistance to acid/base solutions on Cu film			
10%- H_2SO_4	;30 minutes	No peel off	Tape peeling test after dipping at 23 deg. C
10%- HCl	;30 minutes	No peel off	
5% - NaOH	;30 minutes	No peel off	

11) Test pieces; pattern of cover coat; TM 2.4.28.1 of IPC-TM-650, PI-Cu substrate: Upisel-N (PI/Cu=25/12μm)

10. Resistance of electrolytic / electroless Ni / Au plating process

Electroless Ni / Au plating	No penetration & No peel off	NPT process [12], Tape peeling test [11]

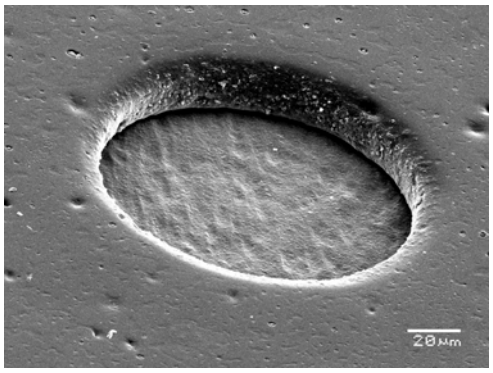
12) Conditions of electroless Ni / Au plating process (NPT process)

	Process	Solution	Condition
i)	Acid Cleaner	IPC Clean S-135 [13] 200ml/l	40 deg. C- 4 minutes
ii)	Soft etching	$(NH_4)_2S_2O_8$ 100g/l, H_2SO_4 10ml/l	23 deg. C- 1 minute
iii)	Smut removal	10% H_2SO_4	23 deg. C- 1 minute
iv)	Pre-dipping	3.5% HCl	23 deg. C- 1 minute
v)	Activation	IPC Accera[13] 200ml/l	23 deg. C- 1 minute
vi)	Electroless Ni plating	IPC Nicoron GM-SD[13] Ni content 5.0g/l, pH 4.6	80 deg. C- 20 minutes Thickness of Ni plating - about 3μm
vii)	Acid dipping	3.5% HCl	23 deg. C- 1 minute
viii)	Electroless Au plating	IM-GOLD IB[14] Au content 2.0g/l, pH 4.8	85 deg. C- 20 minutes Thickness of Au plating- about 0.08μm
ix)	Washing	Ion-exchanged hot water	80 deg. C- 10 minutes
x)	Drying	Box oven	80 deg. C- 3 minutes

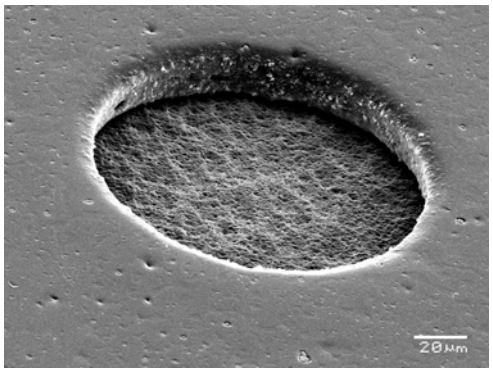
13) ICP Clean S-135, ICP Clean 91, ICP Accela, ICP Nicolon GM-SD, and Top Selena; made by Okuno Chemical Industries Co.,Ltd.

14) IM-GOLD IB, Acid strike, Tempereist – EX ; made by Japan Pure Chemical Co.,Ltd.

11. SEM Photograph



on Cu substrate (Upisel N)



on PI film (Upisel N)

12. Electrical Properties

Reliability Test Results			Typical value	Reference data
Insulation resistance (ohm)	Line / Space=50 / 50μm		6×10^{13}	23 deg. C/55%Rh
	Line / Space=100 / 100μm		8×10^{13}	
Surface Resistance (ohm)			3×10^{13}	TM 2.5.17 of IPC-TM-650
Volume Resistivity (ohm・cm)			1×10^{16}	TM 2.5.17 of IPC-TM-650
Dielectric Constant (εr)		1 MHz	4.11	JIS C6481, 1MHz
Dielectric Loss Factor (tan δ)		1 MHz	0.029	JIS C6481, 1MHz
Dielectric Strength			162 kV/mm	TM 2.6.11 of IPC-TM-650

13. Reliability Test Results

HHBT Line / space = 50μm / 50μm (measured resistance condition at test condition)		After 750 hours	No dendrite ($> 10^8$ ohm)	85 deg. C/85%Rh/100V DC Electrolytic Cu foil
		After 1000 hours	No dendrite ($> 10^8$ ohm)	
HHBT Line / space = 100μm / 100μm (measured resistance condition at test condition)		After 750 hours	No dendrite ($> 10^9$ ohm)	85 deg. C/85%Rh/100V DC Electrolytic Cu foil
		After 1000 hours	No dendrite ($> 10^9$ ohm)	
PCT	on Cu substrate		No peel off	121deg. C/0.2MPa/98h Tape peeling; Checker flag type, Test pieces; IPC-TM-650 No. 2.4.28.1
	on PI film		No peel off	
Degradation Temperature	in N_2	5wt% Loss	307 deg. C	TGA method (40 deg. C/min.)
		1st dissolution	367 deg. C	
	in Air (dry)	5wt% Loss	311 deg. C	TGA method (40 deg. C/min.)
		1st dissolution	363 deg. C	

14. Preparation Conditions of Test Pieces

Substrate:		PI: Kapton 100H(25μm), 300H(75μm) PI-Cu: Upisel N (Electrolytic Cu foil; PI/Cu=25/12μm Rolled Cu foil; PI/Cu=25/18μm)	PI; Du Pont-Tray Co., Ltd. PI-Cu; Ube Industries. Ltd.
Thickness of solder mask		About 20 μm	
i)	Preparation of the ink	Hold for 30 minutes after mixing	Used a resin mixer, at room temperature
ii)	Coating	100 meshes polyester-based screen	A hand printing
iii)	Holding	23 deg. C- 10 minutes	In the room
iv)	Pre-Drying	80 deg. C - 30 minutes	Box oven
v)	Cooling	23 deg. C - 30 minutes	In the room
vi)	Exposure	500 mJ/cm^2	7kW, Metalhalide lamp, Scattered light (ORC Manufacturing Co.)
vii)	Holding	23 deg. C - 10 minutes	In the room
viii)	Developing	1%-Na_2CO_3 aq. - 30 deg. C - 60 seconds - 0.2 MPa	NPT developing process
ix)	Rinsing:	City water - 30 deg. C - 60 seconds - 0.2 MPa	NPT developing process
x)	Thermal Curing	150 deg. C - 30 minutes	Box oven

15. Green Procurement Survey

NPR-80/ID60 contains 0.2 to 0.3wt% of an organic pigment. The organic pigment comes under Copper and Copper Compound (No. 26, Substance Group No. D01) in List A (Appendix 2-2, Level B) based on Guideline for Standardization of Material Declaration (on July 22, 2003 revision) published by Japan Green Procurement Survey Standardization Initiative（JGPSSI；http://home.jeita.or.jp/eps/）.

And this product contains 21 to 25wt% (Br content; 9 to 11wt%) of Tetrabromo-bisphenol A compounds as the brominated flame retardant. The brominated flame retardant comes under Tetrabromo-bisphenol A (unspecified, No. 23, Substance Group No. D08) in List A (Appendix 2-2, Level B).

Also, this product is not using the materials/compounds surveyed Chemical Substance except the organic pigment and the flame retardant in the manufacturing process.

16. Special notice

- ✓ Handling
  - The surface hardness of coated film is not hard enough before the thermal curing process. Take it carefully when in handling.
- ✓ Environment of workshop
  - A clean-room under yellow lamp is required.
  - Room temperature: 22 to 26 deg. C
  - Humidity: 50 to 60 %Rh
- ✓ Storage
  - Store at a certain cool and dark area. Temperature in 5 to 25 deg. C is recommendable. Avoid direct sunshine and flame.
  - Hold in room temperature for about 1 day before use, if the storage temperature is under 5 deg. C.
- ✓ Hygienic work Practices
  - Local exhaust is required to be set up in workshop.
  - Wear on suitable protective clothing when in operation.
  - Avoid direct skin contact. Flush with soap and plenty of water thoroughly, if direct contact with skin.
  - Flush hands, face and body with soap and plenty of water after handling.
- ✓ Inflammability
  - The Principal material "**NPR-80/ID60**" is the combustible liquid, and the hardener "**PF-10/ID60**" is the combustible solid. Attention to fire or other sources of ignition.

17. Caution

As to health hazard data, precaution for safe handling/use and others, please refer to the MSDS (Material Safety Data Sheet) of NPR-80/ID60 when in application.

The data mentioned this technical data sheet are based on the results measured NPR-80/ID60 (Green color). In order to get and confirm the sufficient performance, please do the test thoroughly at your end before use.

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