

Resistor Ink and Build-Up Materials for PCB Industries in Korea

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Current Status of Resist Ink and Via Technology for PCB



by J. B. Suh Aug 28th. 2002



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I. Current Market and Application

A. Overview of Resist Ink

- The material for PCB manufacturing together with CCL and wet chemicals.
- The Composites of high polymers as functional coating material.
- Assist electronics industry to meet current market demand
(Light-Thin-Simple-Small with high performance, yet environment friendly)
- Must survive rapid change in Micro Via and Package Substrate technology since
the change causes reorganization among CCL, Resin, and Resist manufacturers.

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I. Current Market and Application

B. Current Status of PCB Market

1. World Market (FY 2001 by NTI)

- Total amount: US\$ bil. 30 (Japan: 25.1%, Asia: 32%, US: 24.4%, Taiwan: 10.5%)
 - Asia combined with Japan supplied 58% of PCB.
 - Korea: US\$ bil. 1.7 (At 5.2% market share, 5th place worldwide),
: However, growth becomes dull currently.
 - China including H.K.: US\$ bil. 3.6 (At 21.1%, 3rd place worldwide),
: China achieved 30% growth from 1999 to 2000.

2. Korean Market (FY 2001 by NTI)

-Total amount

- US\$ bil. 1.9 (bil. 2.1, estimated for 2002)
- Top six PCB makers share is 64% of the total sales.

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I. Current Market and Application

<Tab. 1> World PCB Market (FY 2001 by NTI)

(US\$ mil.)	Normal	Substrate	Micro Via	Rigid Total	% of Total
N. America	6,955	180	155	7,290	24.4
S. America	209	-	-	209	0.7
Europe	4,450	-	416	4,866	16.3
Japan	4,047	2,385	1,055	7,487	25.1
Asia Pacific	8,378	639	678	9,695	32.4
Others	315	10	10	335	1.1
Total	24,354	3,214	2,314	29,882	100.0

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I. Current Market and Application

<Tab. 2> Sales Amount of Korean PCB Manufacturers(unit: bil. Won)

Manufacturers	FY 2000	FY 2001	FY 2002		
			1 st half(achieved)	2 nd half(estimated)	Sum
SSEM	439.2	460.0	260.0	340.0	560.0
DDE	343.2	293.5	140.0	160.0	300.0
LG DMC	330.0	297.0	137.0	213.0	350.0
KCC	253.0	204.3	< 80.0	> 120.0	200.0
DD GDS	165.3	180.8	96.0	106.5	202.5
Petasys	184.0	135.0	65.0	85.0	150.0
Cosmotech	73.8	60.0			
Simmtech	68.7	59.0	27.0		
Q & Tech	40.0	33.0	16.0		36.0
Hitech	60.0	100.0 ?	45.0		120.0
Hunix	52.8	30.0			
Others	426.0	597.4	279.0	348.5	601.5
Total	2,436.0	2,450.0	1,145.0	1,373.0	2,520.0 (estimated)

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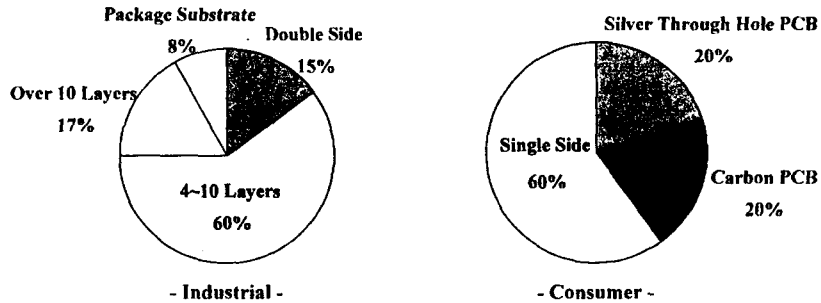


I. Current Market and Application

Total Production (16.7 mil. m² / FY)

- Industrial: 7.5 mil. m²/FY
- Consumer: 9.2 mil. m²/FY

<Fig. 1> Total Production



Application

- Industrial: Rigid & Flexible
- Consumer

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I. Current Market and Application

<Tab. 3> Competitive Industrial PCB in FY 2001

PCB Type	Market Scale (mil. \$)	Domestic Customers	Competitors	Remarks
BUM	300	SSE/LGE/Curitel etc, for cellular	Now : Japan/Taiwan Hereafter : China	
Memory Module	65	SSE/Hynix Semiconductor	Taiwan	
Board for LCD	50	SSE/LG-Phillips		
Package substrate	150	Amkor/Chipac etc, for Package house	Taiwan/Japan	
High Multi-layer MLB	30	Scale is small, but there is domestic communication enterprise base	U.S.A.	
Total	595	31% of Korea PCB Production		

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I. Current Market and Application

C. Korean Resist Market

1. Liquid Type

- World market(FY 2000)
 - 172 K ton (Photo Imaginable Solder Resist)
 - Market share : Korea(6%);
 - Northeast Asia occupys 60%: Japan(14%), Taiwan(22%), China(17%)
- Korean Market(FY2001)

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I. Current Market and Application

<Tab. 4> Korean Market for Liquid Type Resist

Application		Method of Image Transcription	Resolution (L/S 7mil/7mil)	Curing Mechanism	Market		Note Production (unit: mil. m ² /Year)
					Ton/Year	Won/Year (unit: in bil.)	
Consumer	Single Side (STH etc)	Screen Printing	Below	UV	470	4.6	9.2
	MLB (telecommunication, military, computer)			IR (thermal)	65	1.1	
Industrial	Package Substrate	Photo-Lithography	Over	UV & IR (thermal)	850	22.7	7.5 (class T, class H)
					160	5.9	
Total					1,545	34.3	16.7

- Source: based on TAIYO Korea's resist sales volume

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I. Current Market and Application

2. Dry Film Type Resist

<Tab. 5> Korean Market for Dry Film Type Resist

	Area (mil. m ² /year)	Amount (bil. Won)	Remark
Out Layer	7.5	17.0	Total Production of Industrial PCB : 400 mil. m ² /year (D/S 15%, 4~10L 60%, over 12L 25%)
Inner Layer	12.8	35.0	
Total	20.3	52.0	

- Source: TAIYO Korea's solder resist sales volume and PCB maker's out put

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II. Resist Ink

A. Definition

“ A protective coating (ink, paint, metallic plating, etc) used to shield desired portions of the printed conductive pattern from the action of etchant, solder, or plating.”

B. Classification

<Tab. 6> Functional Classification

Class	Function	Characteristics (Demanded Physical Properties)	Remarks
Etching / Plating Resist	• Fabricate Circuits	• Temporary Resist , * Resolution * Etching / Plating Solution Resistance * Easy Stripping	• E/R UV, IR, TD, and Photo(Liquid) • P/R Photo(DFR) and TD
Solder Resist	• Protecting circuits from * Thermal and Chemical Attack (wave soldering) * Thermal Shock and Humid Environment during their Life Cycle.	• Permanent Resist , * Electric Characteristics * Thermal Shock Resistance * Hardness * Resolution	• IR, UV, and Photo Type
Marking Ink	• Marks letters and sign etc..	• the Same as above	• IR and UV Type • Laser Carbonization

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II. Resist Ink

C. Composition

< Tab.7 > Components

Division	I.R	U.V	Photo Imaginable	Function
Resin	Epoxy Resin	Epoxy Acrylate	Modified Epoxy Acrylates, Epoxy Resin	Thermal Shock Resistance, Resolution, Chemical Resistance
Filler	Silica, Talc, Barium Sulfate	Silica, Talc, Barium Sulfate	Silica, Talc, Barium Sulfate	Printability, Hardness Thermal Shock Resistance
Pigment	Inorganic Pigment	Inorganic Pigment	Inorganic Pigment	Give Color
Diluent	Organic Solvent	Monomer	Organic Solvent, Monomer	Fluidity Control
Curing Agent	Amine	Photo Curing Agent	Amine Derivatives Photo Initiator	Productivity, Chemical Resistance
Additives	Additives Thixotropic Agents	Additives Thixotropic Agents	Additives Thixotropic Agents	Coating Uniformity, Printability

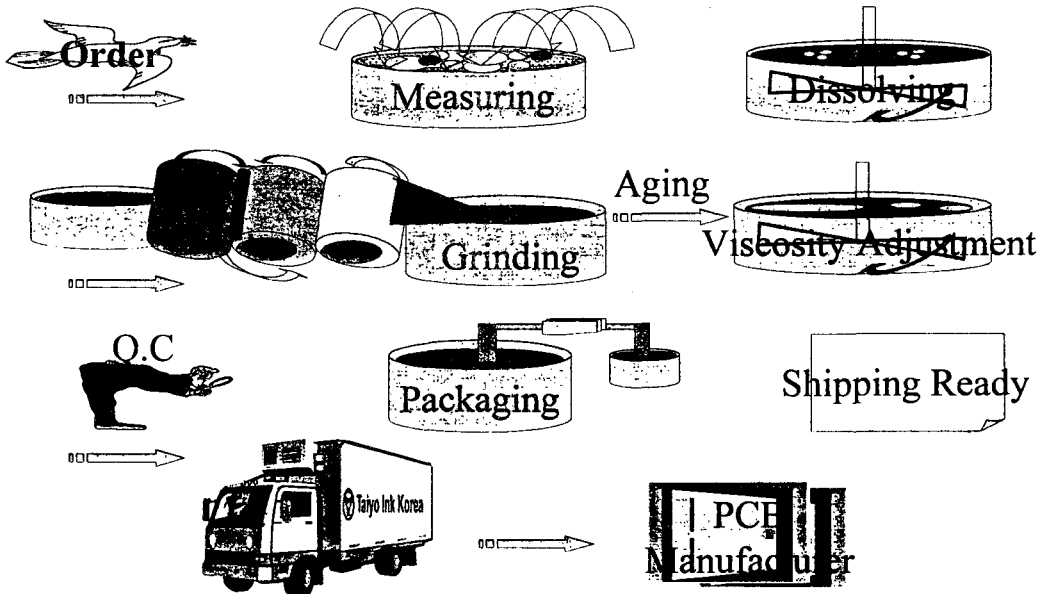
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II. Resist Ink

D. Manufacturing Process

<Fig.2> Sequential Stage Map



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II. Resist Ink

E. Coating Method

<Tab. 8> Selected by PCB design spec. such as thickness of coating, hole plugging and productivity etc.

Method	Advantage	Disadvantage	Remarks
Screen	<ul style="list-style-type: none"> • Thin Board Coating • Uniform Coating • Ease of Hole Plugging 	<ul style="list-style-type: none"> • Low Productivity • High Running Cost • Drying Only One Side at a Time 	<ul style="list-style-type: none"> • Consumer PCB (etching and solder Resist, and marking ink) • Industrial PCB (the same as above)
Spray	<ul style="list-style-type: none"> • Auto-Mass production for various PCB models • Thin Board Coating • Drying Window Control • Dual Surface Printing 	<ul style="list-style-type: none"> • Less environment-friendly (solvent rich) • Large Ink Loss • Uneven Coating 	<ul style="list-style-type: none"> • Industrial PCB (solder resist)
Roll	<ul style="list-style-type: none"> • Dual Surface Printing • Auto-Mass Production for Various PCB Models • Thin Board Coating • Via Hole Tenting • Uniform Coating 	<ul style="list-style-type: none"> • Less Environment-Friendly (solvent rich) • High Running Cost • Limited Application 	<ul style="list-style-type: none"> • Industrial PCB (etching and solder resist)



II. Resist Ink

F. Items of Resist Quality Design

1. Criteria of qualification/conformance for solder mask

(Summary of criteria of qualification/conformance: IPC-SM-840C)

<Tab. 9> Classes Based on Industry/End Use Requirements

Classes	Application	Identical	Different	Remarks
T	Telecommunication	In Visual, Cure, Non-nutrient, Pencil hardness, Adhesion, Hydrolytic Stability/Aging	In Flammability-UL94, Moisture & Insulation Resistance, Thermal Shock	
H	High Reliability/Military			



II. Resist Ink

<Tab. 10> Selected Items for Comparison between T & H

Test Items	Classes	Conditions Temp/RH	Bias Voltage (VDC)	Test Voltage (VDC)	Duration	Pattern	Requirement (mega ohms)
Moisture & Insulation Test (comb)	T	65℃/90%	None	100.00	24hr	B-25A or B-25	500
	H	25~65℃ / 85%	50	100	6 ² / ₃ days	B-25A B-25	100 500
Moisture & Insulation Test (V)	T	65℃/90%	None	100.00	24hr	B-25A or B-25	500
	H	25~65℃ / 85%	50	100	6 ² / ₃ days	Y pattern	500
Electro-chemical Migration	T	85℃/85%	10.00	45~100	500hr	B-25A B-25B or E	< 1 decade drop in resistance
	H	85℃/90%	10.00	10.00	168hr	B-25B or E	Resistance ≥ 2 mega ohm
Flammability (UL94)	T	The "V" number shall not be raised more than 1. V-1 minimum					
	H	The "V" number shall not be raised					
Thermal Shock Conditions	Class			Temperature		Number of cycles	
	T (only when specified)			-65 to +125℃		100	
	H			-65 to +125℃		100	

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II. Resist Ink

2. Additional Spec.

1) Safety

: Mist Free, Low Halogen, Low Toxicity

2) Productivity

: Pot Life, Tacky Freeness, Photo-Sensitivity, and Adaptability for Auto Coating Equipment

3) Special Properties

: High Resolution, Flexibility, Matte Surface, etc.

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III. Technical Trend

A. Issues of R & D

I. To Comply with Environment Regulation

- a. Halogen Free
- b. Lead Free
- c. Low Toxicity
- d. Low Mist



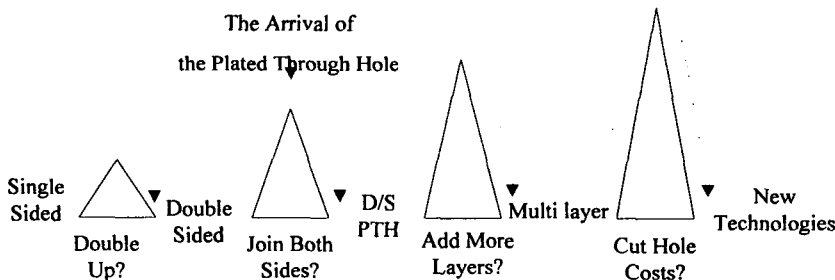
III. Technical Trend

II. High Density Interconnection / High Functionality

: Why Via Technology Is So Essential?

To make designing possible for an assembly with more than 20 attachment vias per cm² or with array components of less than 1 mm pitch

<Fig. 3> Shifting Technology for Gaining Higher Density Interconnection





III. Technical Trend

B. Market / Application

1. World (FY 2001 by NTI)

- Total Amount: US bil. 3.8 (9.0% of World PCB Production)

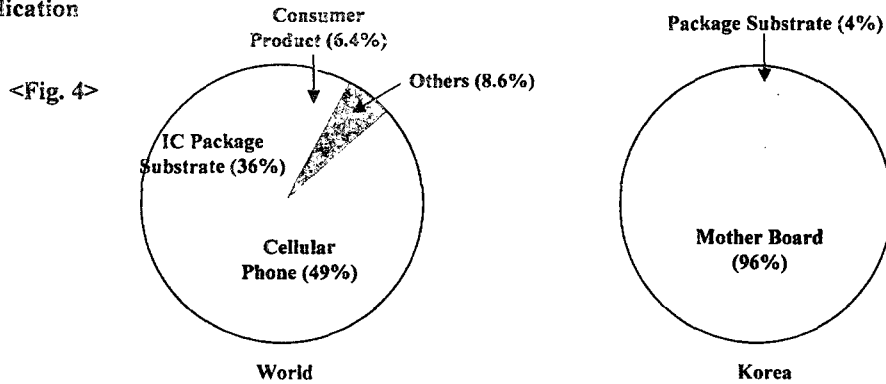
- Application

2. Korea (FY 2001)

- Total Amount: US mil. 300

Total Production: BUM 10% of Total Industrial PCB.

- Application



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III. Technical Trend

C. Micro Via Technologies

1. World

: Technology Based on Production Amount - LASER Via(73%), Stack Via by Bump(15%), Others(13%)

<Tab. 11> Various Micro Via Technologies

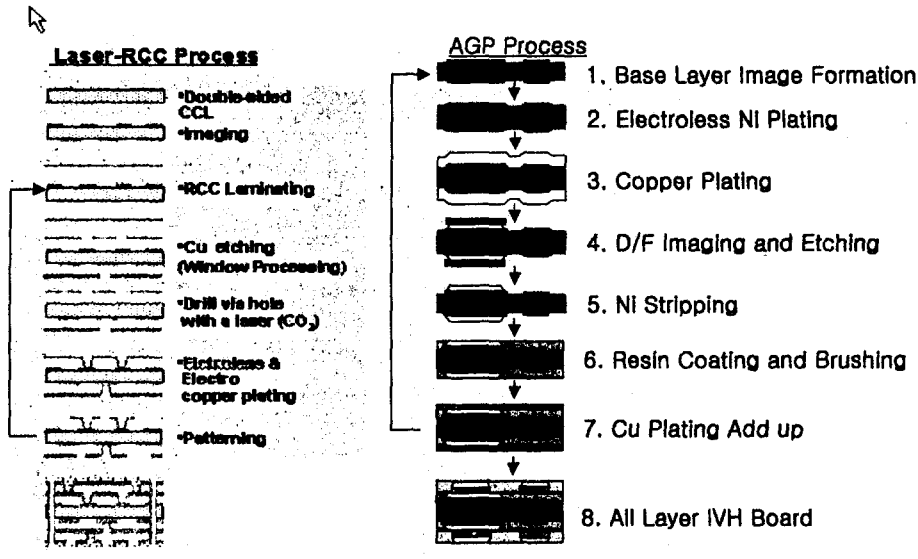
Items	Inventors	Market Share	Via Formation	Inter-connection	Dielectric Material	PCB MFR	
Photo	IBM Yasu	12.8%	Photo	Plating	Ink(Vantico) Captive	IBM, IBIDEN	
LASER	RCC	Hitachi ?	LASER	Plating	RCC(Mitsui, Matsushita)	AT&S, Aspocomp	
	PP	-	LASER	Plating	Laminate	AT&S	
	Liquid	-	LASER	Plating	Thermal Curable Ink	JVC, Samsung	
	Film	-	LASER	Plating	Dry Film (Ajinamoto)	Shinko, IBIDEN	
STACK	B ² it	Toshiba	Bump	Screen Printed Bump(Ag Paste)	Prepreg	Toshiba	
	ALIVH	Matsushita	LASER	Hole Filling by Cu Paste	Aramid	Matsushita, CMK	
	NMBI	North	Start	Bump	Etched Bump	Prepreg	LG Licensed
	PALUP	Denso	Start	Bump	Fused	Thermoplast	New
	AGP	DAIWA	Start	Bump	Etched Bump	Thermal Curable Dielectric PPG	

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III. Technical Trend

<Fig. 5> Process Comparison Between Laser-RCC and AGP



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III. Technical Trend

<Tab. 12> Build-Up Materials

Items		Manufacturers	Characteristics	
			Good	Bad
Special Copper Foil		Mitsui(Thin)	Laser Drillable	Expensive and Handling
Glass Fiber	Flat Type	SP Cloth (Nittobo) MS Cloth (Asahi)	Glass Filament Spreaded by Water Jet to Make Uniform and Flat Glass	Expensive
Resin	RCC	Mitsui Matsushita	Easy Handling and Good for Volume Production	Shrinkage & Bad Dimension Stability
	Prepreg	Laminate Manufacturer	Cheaper than RCC High Stiffness(less warp)	Laser Productivity Hole Reliability
	Aramid	Shinkobe	Laser Productivity	Expensive
	Film	Ajinamoto(ABF)	Laser Productivity	Productivity(Extra Baking & Vacuum Lamination)
	Photo Image	Ciba Geigy(Vantico) IBIDEN	Productivity	Small Hole Formation
	Thermal Cure Ink	Taiyo	Productivity	Surface Flattening & Desmearing
Hole Filling Ink		Sanei (PHP-900)	Less Volume Shrinkage	Very Expensive

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III. Technical Trend

2. Korea

a. Current

<Tab. 13> Technology Level of Current

Items	Current (2002.7)	Competitors	
		Japan (2000.1)	Taiwan(2001.2)
Share In MLB Production	10% (750Km ² /Y)	1.73KKm ² /Y	360Km ² /Y
No of Manufacture	5	40	11
No of LASER	120	300(?)	200
Minimum Via Hole Size	CO ₂ 100 μm YAG 50 μm	CO ₂ 100 μm YAG 50 μm	CO ₂ 100 μm YAG 50 μm
Build -Up Structure	1+6+1, 2+4+2	1+6+1, 2+4+2, 3+2+3	1+6+1, 2+4+2
Shape of Stack Via	1~2 Via, 1~3 Via	Stack Via 1~2 Via, 1~3 Via	1~2 Via, 1~3 Via

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III. Technical Trend

b. Target of R & D

1) MLB

- a. To develop low cost process without using LASER drill
- b. To perform gang lamination in stead of sequential lamination

2) Package

a. FC-BGA (Flip Chip Ball Grid Array)

* Stack Via Formation

By plating for Field Via

* Outside Layer Solder Resist

By liquid or DFR type

By Via Hole Tenting with vacuum laminators

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