PCB의 최신 기술 동향

전무 **이 진 호**
(대덕전자)

PCB Market and Technology Changes Driven by Mobile Phone

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Title

1.휴대폰
2. PCB의 변화
3.Material의 변화
4.Via Type
5.Environmental Issue
6.Stack Via
7.PCB Finish
8.Embedded Passive

1. 휴대폰_ 국내 휴대폰 / Microvia PCB생산 현황 (NTI)

1) 2002년 국내 Microvia 생산고(전체PCB중 17%)

업체	U$M
SEM	185
DE	122
Etc.	93
Total	400

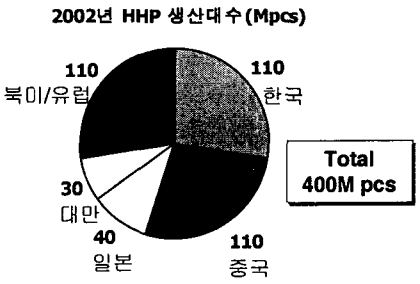
거의 대부분 HHP용
Microvia Capa : 100,000 ㎡/月
Laser drill : 약185台

2) 2002년 국내 HHP 생산실적

업체	백만대
Samsung	43
Nokia	35
LGE	16
P & Critel	4
Etc.	12
Total	110

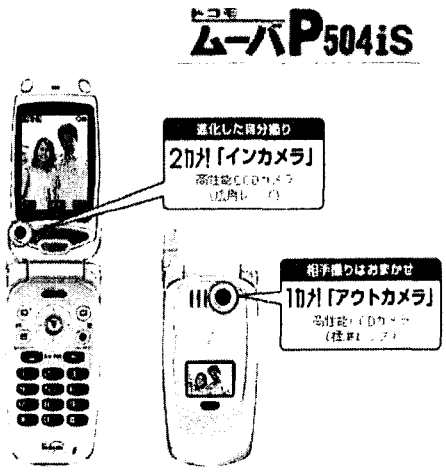
⇒ **2003년 140M 대 전망**

3) 2002년 세계 HHP 생산실적



<N.T.Information 추정>

1.휴대폰_Camera Phone의 출현



변화 : - Rigid-Flex 채용 - Camera용 Optical Module 소요

1.휴대폰_ 분해도

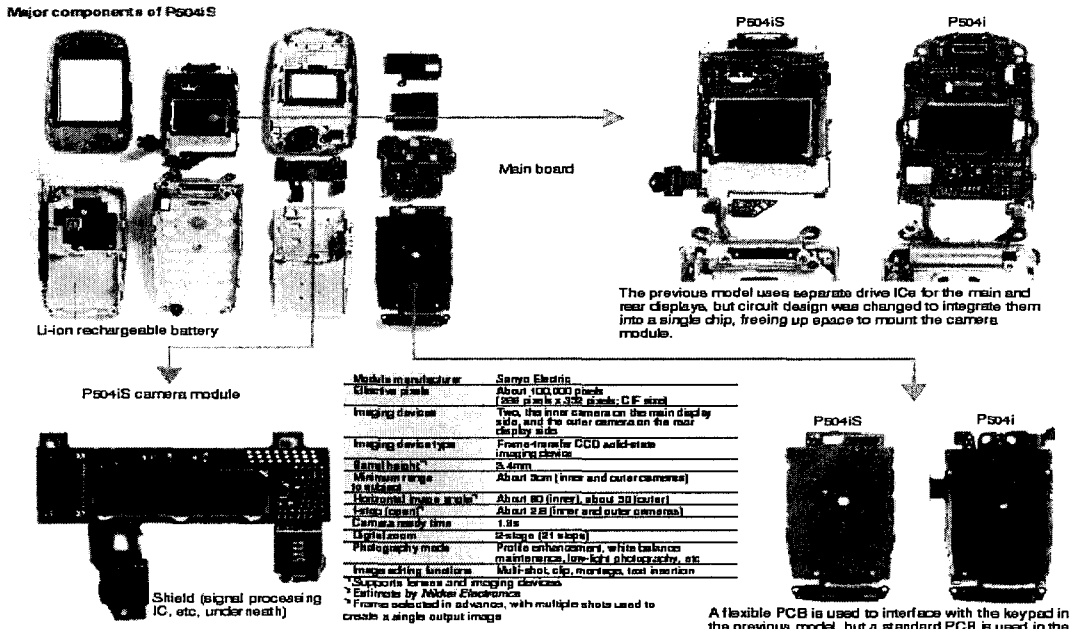


Fig 4 Major Component Changes in Mova P504iS Shows the key components of the Mova P504iS mobile phone, and major changes from the prior P504i model.

1.휴대폰_Optical Module

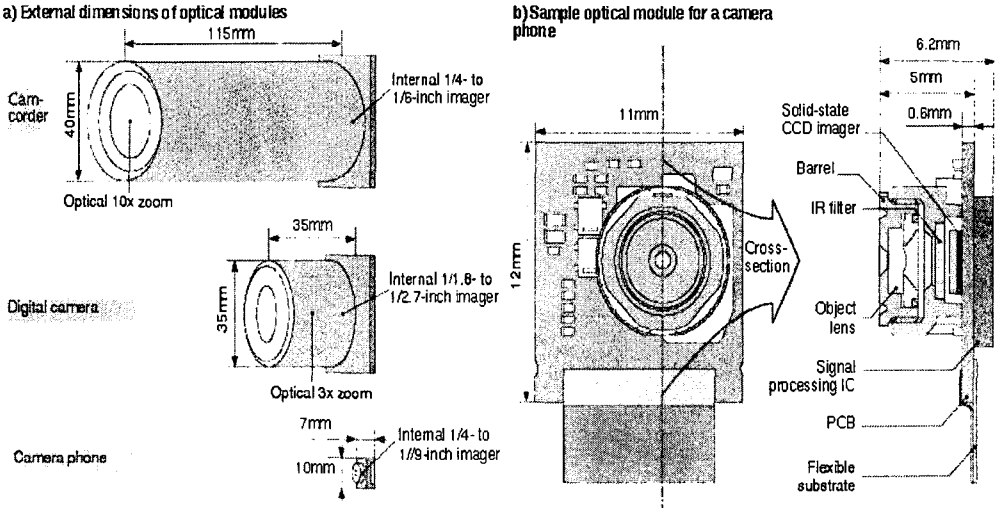


Fig 3 Camera Phones Need Miniature Cameras Optical component manufacturers are gearing up to meet the challenge of the huge cell phone market. Optical modules for camera phones must be small and thin, as is evident in a comparison with the modules for camcorders or digital cameras (a). Many camcorder optical modules are especially large because, even though the imaging device itself is smaller than that used on a digital camera, they have a 10x zoom function. Most digital cameras, on the other hand, are smaller with only 3x zoom capabilities. Even so, camera phones demand significantly smaller modules, and the same modules must also handle exposure control and color balance (b). Technologies developed for these market requirements will drive the entire camera industry. Note that (b) is an example of a product from Sanyo Electric, with a 1/7-inch CCD imaging device with a total of 110,000 pixels.

1. 휴대폰_한국의 Rigid /Flexible PCB 생산 현황

단위: $ Million

Makers	2000年	2001年	G/R	2002年	海外	G/R
Samsung E. M.	367	383	4.4%	462		20.6%
Daeduck Group	440	427	-3.0%	428	30	0.2%
KCC	284	281	-1.1%	280	15	-0.4%
LGE	312	273	-12.5%	320		17.2%
Isu-Petasys	147	112	-23.8%	110		-1.8%
Young Poong	34	47	38.2%	67		42.6%
Cosmotech	64	50	-21.9%	48	3	-4.0%
Simm Tech	69	49	-29.0%	45		-8.2%
SI Flex.	32	39	21.9%	59		51.3%
Hunix	53	47	-11.3%	43	17	-8.5%

年度別 韓國 Flexible PCB 生産現況(단위:억원)

業體名	97年	98年	99年	2000年	2001年	2002年	2003 豫想
Interflex	20	130	329	495	640	1151	1800
永豊電子	42	219	354	532	588	1067	1600
SiFlex	39	227	276	374	464	760	1200
其他	29	50	60	100	400	500	400
계	130	650	1,000	1,500	2,000	3,500	5,000

2.PCB 의 변화

1.기능면: 카메라 기능 부가/ Optical Module 소요

2.Material: RCC → Prepreg

일반 FR → Halogen Free FR-4

3.Design / Process : Stack Via

Rigid → Rigid-Flex

4.Finish : Immersion Gold(ENIG) → Hybrid(OSP + ENIG)

Immersion Gold(ENIG) → High P Type

5.Quality/Reliability:

Warpage/ Mechanical or Thermal Stress

Solder Void in Microvia

2 meter Drop Test

Black Pad Issue

SO2 Corrosion on Key Pad

6.Future Technology : Embedded Passive

2.PCB의 변화_Hole Type에 따른 회로 밀집도

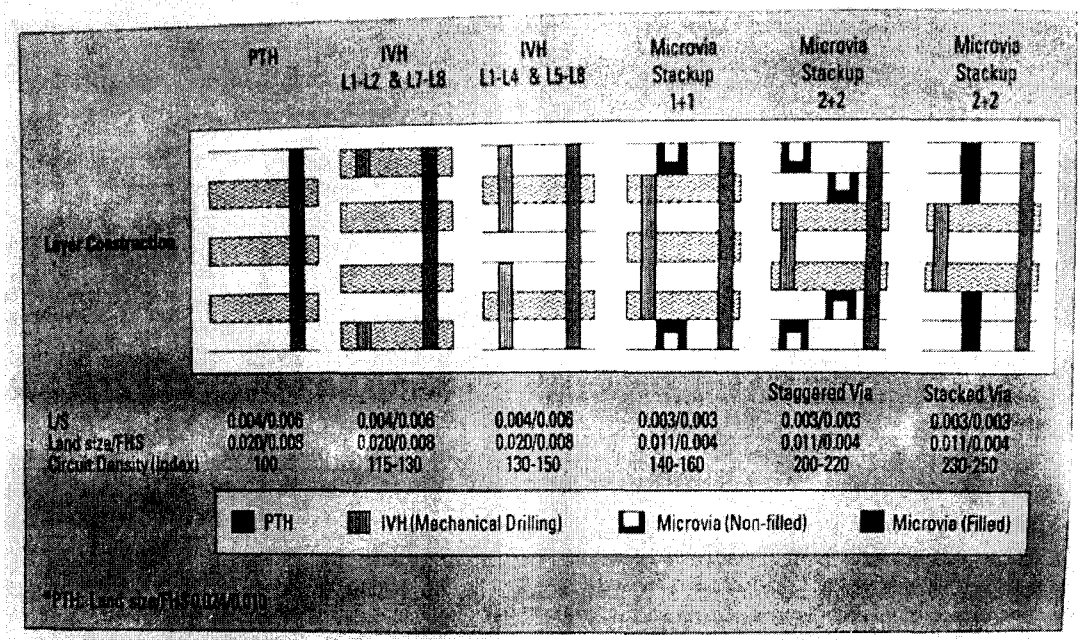
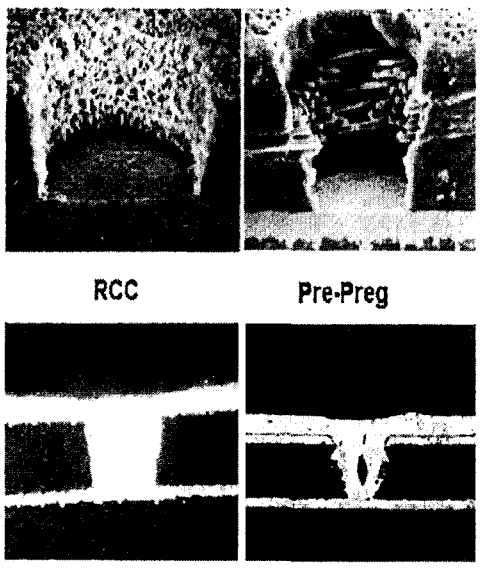
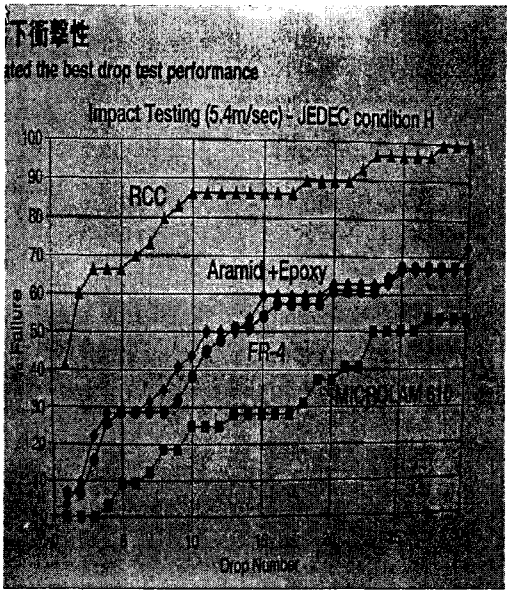


FIGURE 7. Circuit density comparison by hole type.

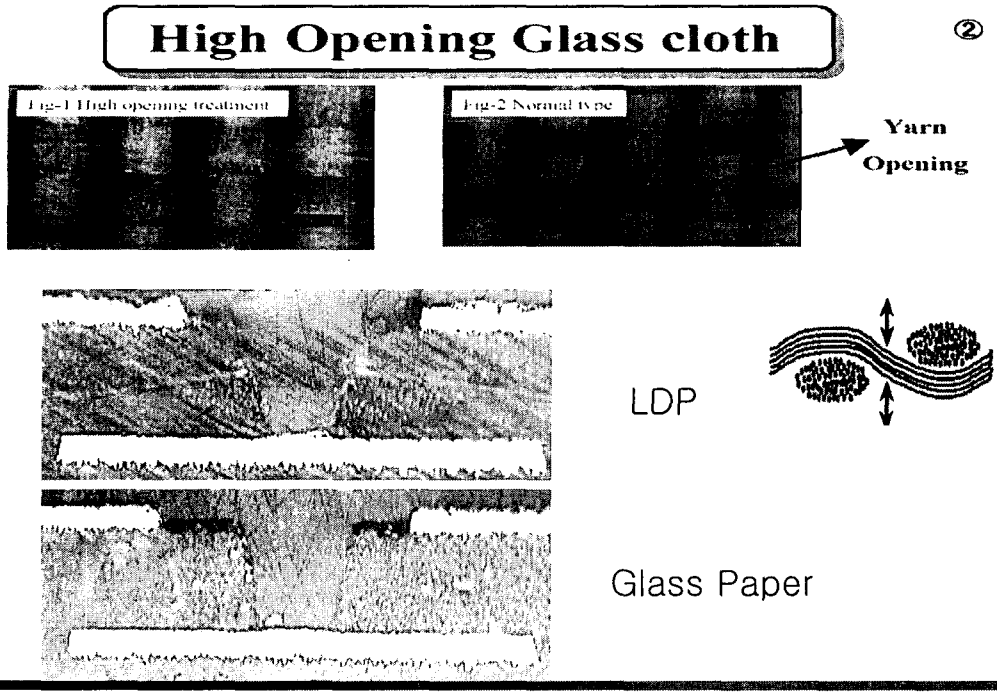
3.Material의 변화_ RCC → Prepreg

Effect of glass reinforcement after laser ablation (top) and copper via fill (bottom)

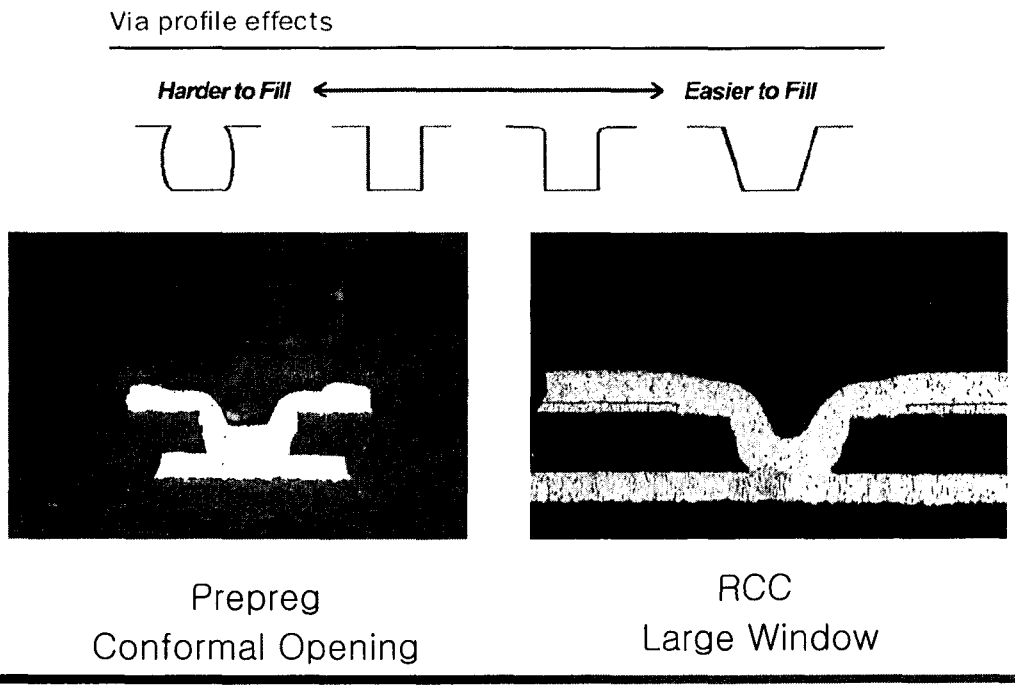




3.Material의 변화_ Laser Drillable Prepreg



4.Via Type_ Conformal vs Large Window Opening



4.Via Type_ Beam Saping for uVia

Beam Shaping for MICROVIA DRILLING

PC Fab(Feb 2003)

by TODD E. LIZOTTE

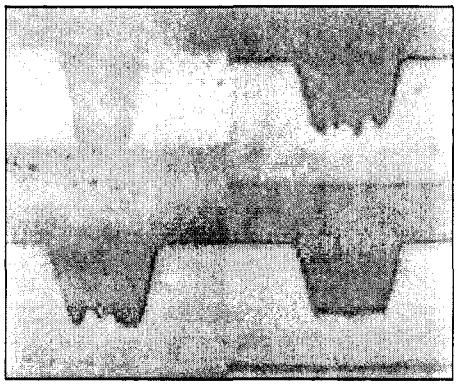


FIGURE 6. Beam variations and cross-sections of the via hole profile as it penetrates the material. In some cases, the variation is two times.

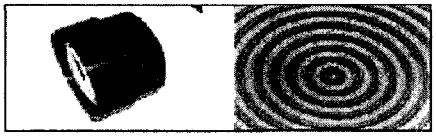


FIGURE 2. Beam shaping optics include refractive (left) and diffractive designs.

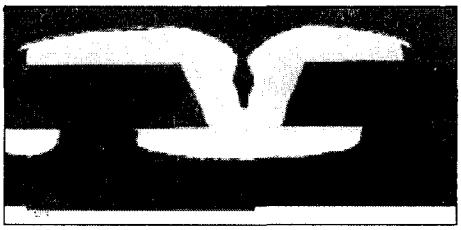


FIGURE 8. The imaging system permits control of beam profile at the target, resulting in uniform microvia holes.

5.Environment_ EU Directive

RoHS (Restriction of Hazardous Substances)규제대상 물질:

Pb, Hg, Cd, Cr+6, PBB, PBDE

2002년 11월19일 JEITA(일본전자정보기술산업협의), 유럽대표(Soldertec), NEMI(미솔전자 기기 제조자 협회)가 다음 사항을 결의

- 2001년말까지 1제품이라도 Pb Free Solder채용
- 2005년말까지 전제품 Pb Free

-2006.07.01 유럽에서 유해물질규제(RoHS) 시작

-미국 : 캘리포니아 환경법으로 1986년 발효됨. 인체에 유해한 화학성분(특히 납)을 함유하고 있는 모든 제품은 적절한 주의 사항을 소비자 및 작업자에게 반드시 알리도록 하는 환경법. '03년 이후 출시되는 모든 제품에 대해서 경고 문구 삽입 의무화

PCB 대응 :Halogen Free(원판/PSR)과 Pb Free 대응으로 High Tg 제품 사용

5.Environment_ Issue

Items	Material	Conventional	Green
Laminate (Flame Retardant)	**Br**	**Brominated Epoxy(w/TBBPA)) Br : 7.5% Wt %**	**Phosphor** Br: < 0.01% Wt %
RCC	Br	Br : 16 % Wt %	Br : < 0.01 Wt %
Solder Mask Pigment	**Cl**	**Phthalocyanine Green Cl : 2,500ppm**	**Phthalocyanine Blue Cl : 320 ~ 350ppm**
Finish	**Pb**	**HASL (Sn/Pb)**	**OSP, ENIG, Immersion Tin**

TABLE 1. Worldwide Demand for Green Laminates[3]

PRODUCTS	2000	2002	2005	2007
Digital cellular mobile handsets	105.5	284.4	4765.6	8922.2
PDA/handheld computers	16.11	62.71	1096.4	3643.9
Digital camcorders	0.39	1.19	433.5	1045.2
Portable computers	80.8	439.5	2459.2	9588.2
Digital cameras	0.73	1.77	343.6	563.2
Total	203.5	789.6	9098.3	23,762.7

In 000 m^2. Source: BPA

5.Environment_ Green Laminate Quality

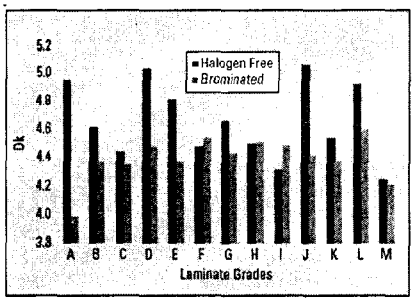


FIGURE 4. Dielectric constant of moisturized laminates measured at 1 GHz MHz.

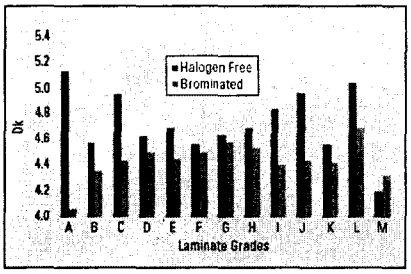


FIGURE 1. Dielectric constant of dry laminates measured at 10 MHz.

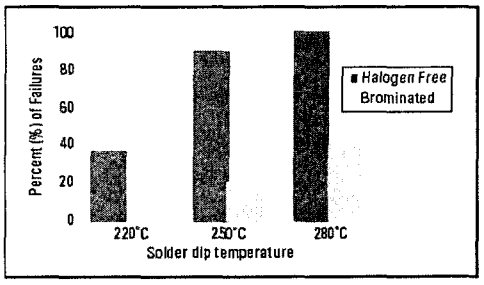


FIGURE 10. Solder dip failure versus temperature.

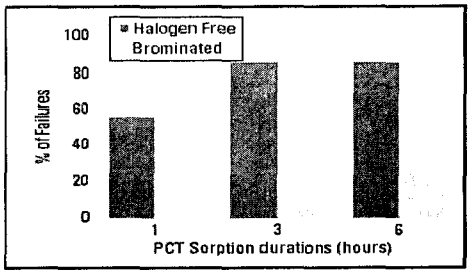


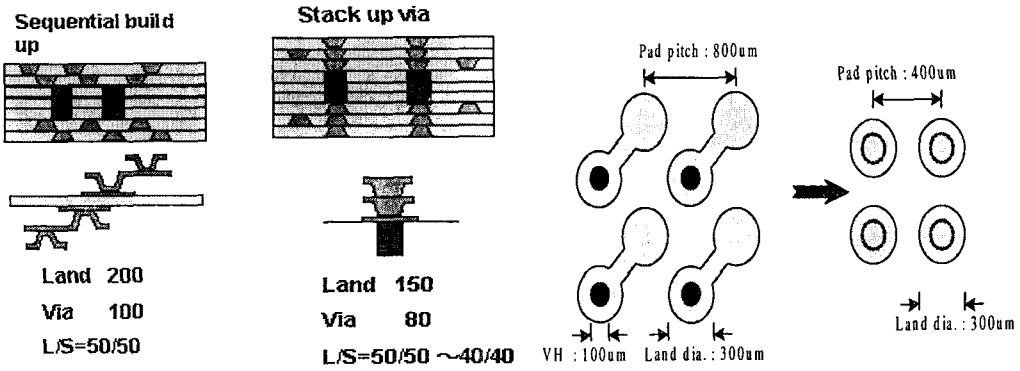
FIGURE 8. Solder dip failure versus PCT duration.

PC Fab. Mar 2003

6.Stack Via_ Design Requirement

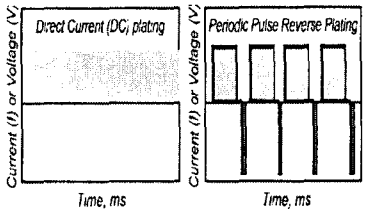
High design flexibility

- Via hole density increase because via hole diameter decrease.
- Via hole density increase because pad pitch is reduced.
- All layer IVH design is possible.

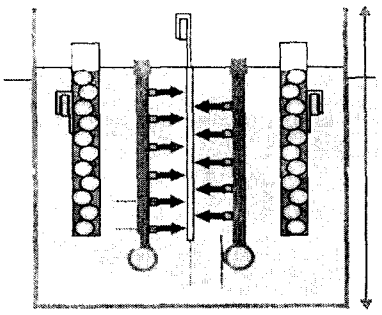


6.Stack Via_ Via Fill Plating System

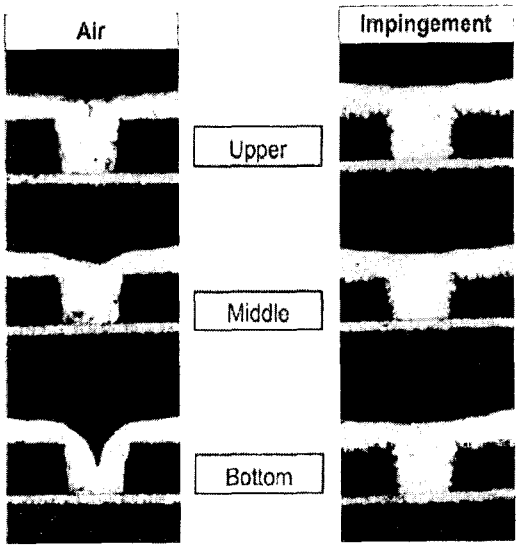
Waveform options



Side view of via fill plating cell

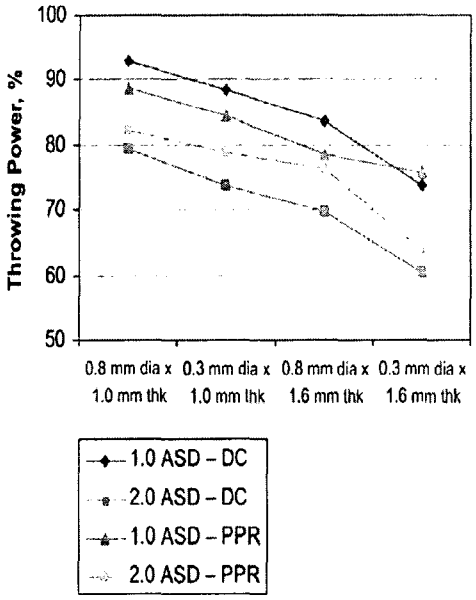


Effect of agitation on filling uniformity

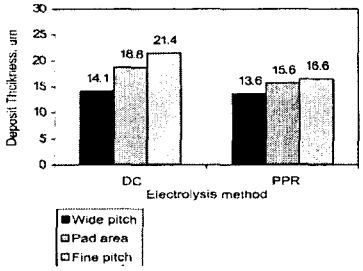


6.Stack Via_ DC vs Pulse Plating

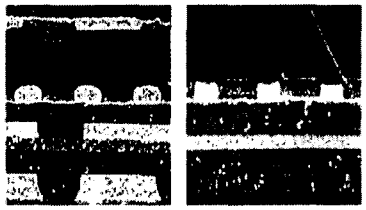
Copper via fill through hole throwing power



Comparison of DC and PPR on pattern surface distribution



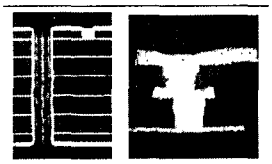
Comparison of DC and PPR on pattern shape

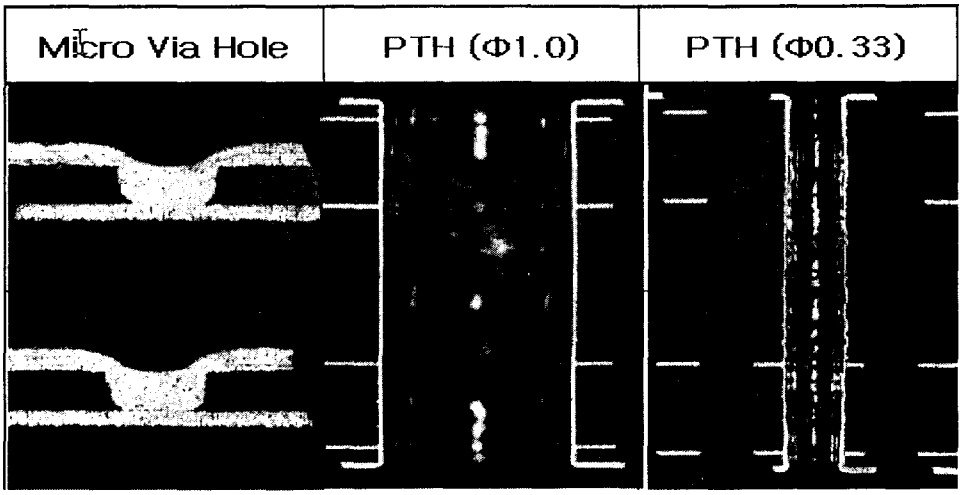


6.Stack Via_ Microvia and PTH

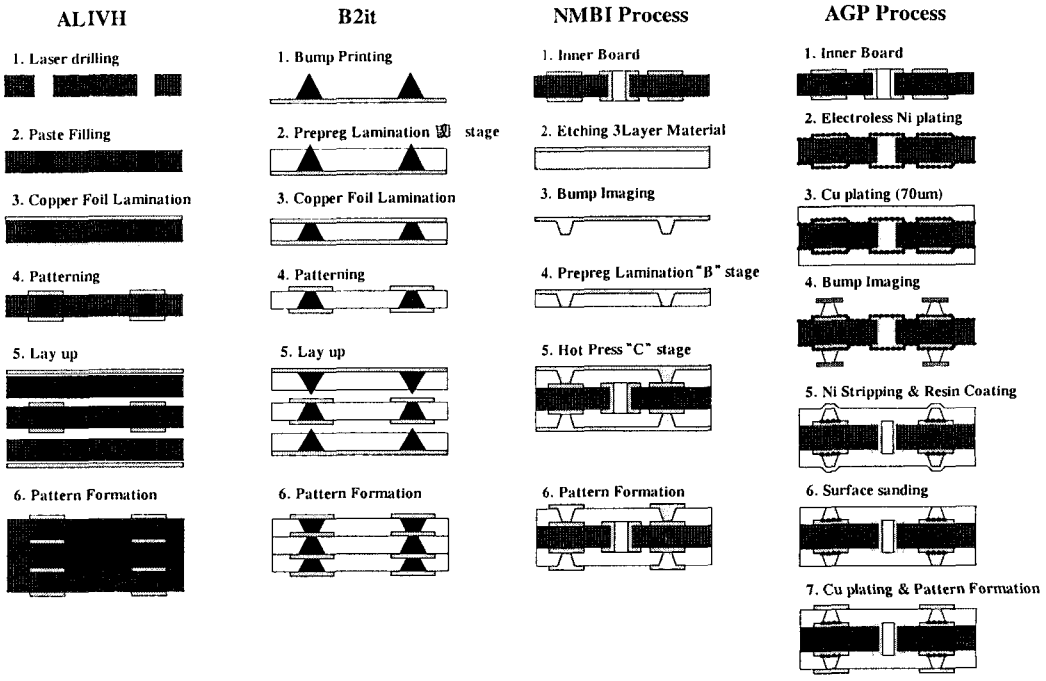
Difficult to fill Micovia and PTH at the same time.

Examples of copper filled vias





6.Stack Via_Other Stack Via Technology



7.PCB Finish

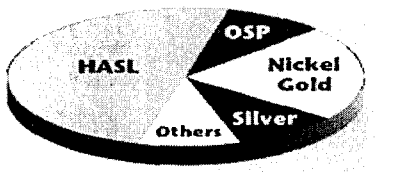


Figure 2. Use of PCB surface finishes 2002 est. (Source: IPC TMRC).

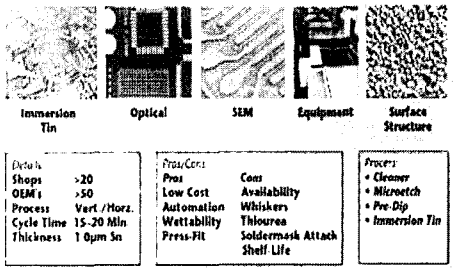


Figure 6 Immersion Tin (Photos A, B, C, D, E) and Blue Table

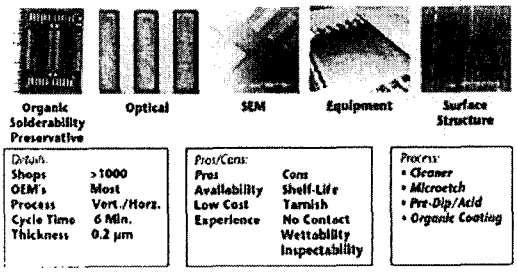


Figure 4 OSP Presentation (Photos A, B, C, D, E) and Blue Table

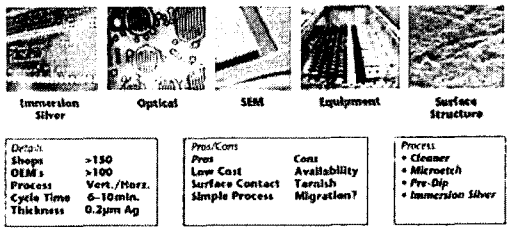


Figure 7 Immersion Silver (Photos A, B, C, D, E) and Blue Table.

7.PCB Finish_ENIG (Electroless Nickel + Immersion Gold)

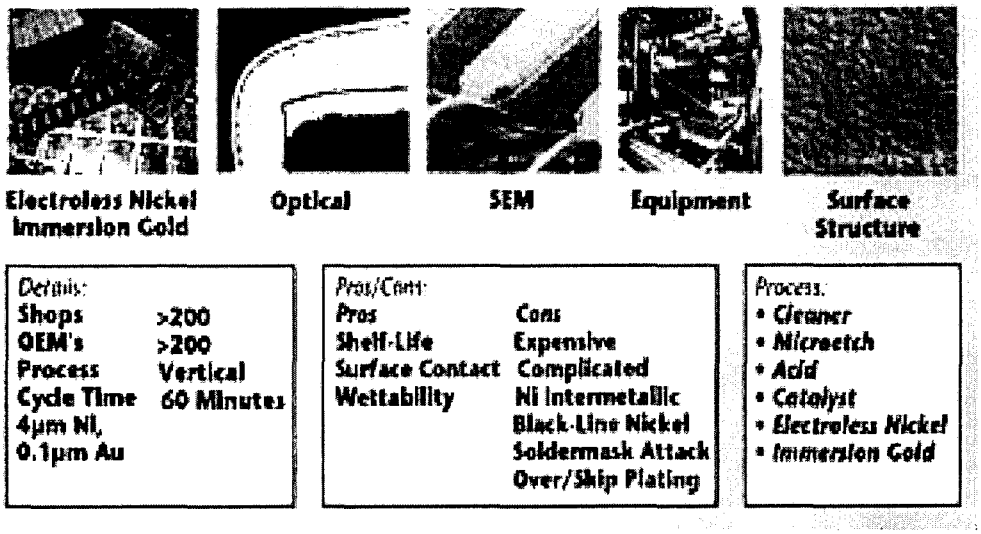


Figure 5. ENIG Presentation (Photos A, B, C, D, E) and Blue Table.

7.PCB Finish_ Black Pad Issue

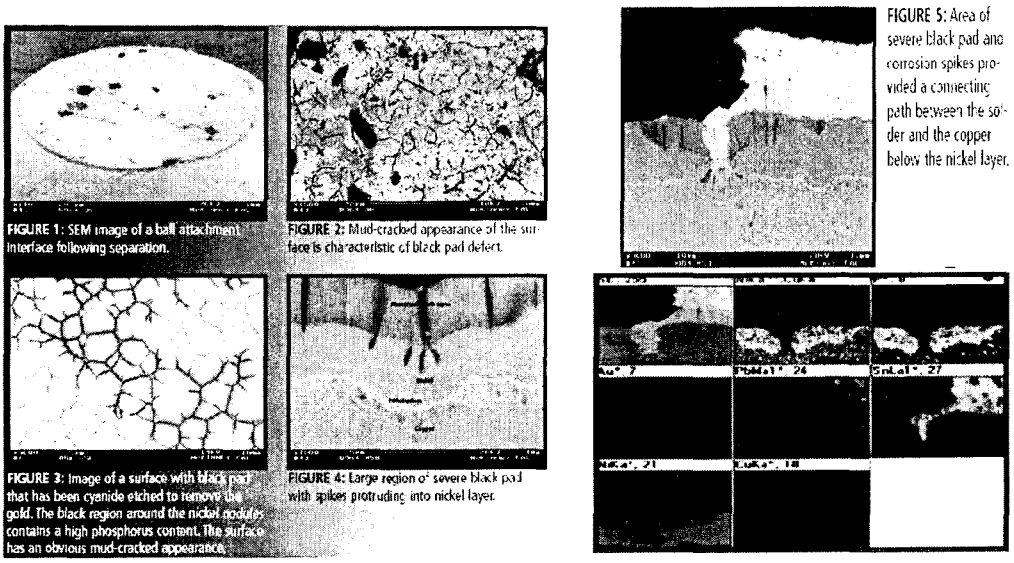


FIGURE 1: SEM image of a ball attachment interface following separation.

FIGURE 2: Mud-cracked appearance of the surface is characteristic of black pad defect.

FIGURE 3: Image of a surface with black pad that has been cyanide etched to remove the gold. The black region around the nickel nodules contains a high phosphorus content. The surface has an obvious mud-cracked appearance.

FIGURE 4: Large region of severe black pad with spikes protruding into nickel layer.

FIGURE 5: Area of severe black pad and corrosion spikes provided a connecting path between the solder and the copper below the nickel layer.

ENIG(Key Pad/Soldering Pad)→ ENIG(KP)+OSP(SP)

8.Embedded Passive_ Issue

Embedded Passive

It is the hot topic in the last two years. However,

Is the technology practical?

Basic concepts are not fixed yet.

Total cost must be reasonable.

Realistic feasibility studies should be done.

Many kinds of materials

Design will a bottle neck.

Patent of Zycon is a issue.

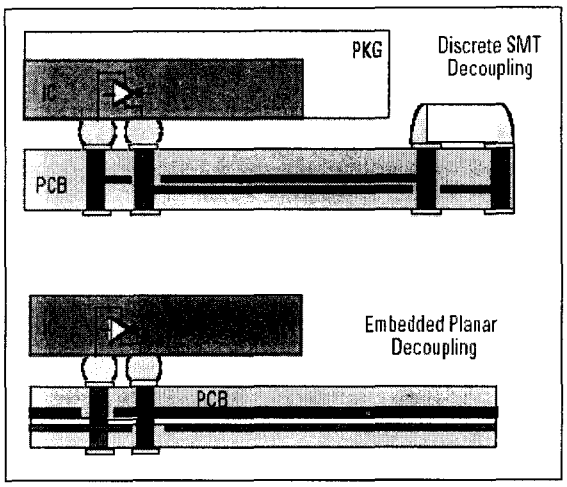


FIGURE 2. A power and ground plane pairing can create a capacitance of 250 nF, eliminating 30 to 40% of the SM decoupling capacitors from a board.

8.Embedded Passive_Embedded에 대한 Question과 적용 시기

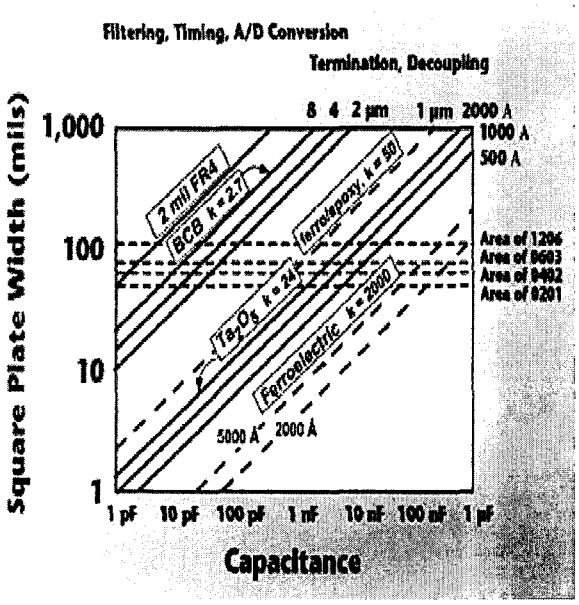


표 4. 부품 내장 기판 수요

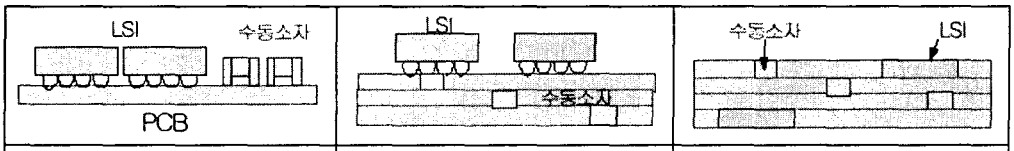
	2003년	2005년	2007년	2009년	2010년
노트북 PC	없음	없음	C, R, L 필터		LC
디지털 TV	없음	없음	[illegible]		필터, L
[illegible]	없음	없음	[illegible]		LC 필터
휴대전화	없음	[illegible]	L 필터		
웨어러블 PDA	없음	없음	[illegible]	L, C 필터	

여기에서 R 저항, L 콘덴서, L 코일부품

8.Embedded Passive_개발동향(삼성전기 중앙 연구소)

<table>
<tr><th></th><th>개 발 동 향</th></tr>
<tr><td>Buried Capacitor</td><td>Buried Capacitor에 대한 주된 요구는 전기특성 향상 (Noise 감소)이나 수 pF 이상의 Capacitor를 내장할 수 없음. (고용량 C 대응 불가)
<table>
<tr><th></th><th>일반 Capa.</th><th>Buried Capa.</th></tr>
<tr><td>Density</td><td>60%이상: 1nF/10nF</td><td>Max 0.5nF</td></tr>
<tr><td>Size</td><td>1 ×0.5mm</td><td>25 ×25mm</td></tr>
</table></td></tr>
<tr><td>Buried Resistor</td><td>Buried Resistor는 저항 Tolerance가 우수하고 공정 진행 시 저항값 변화율이 적다는 장점이 있으나 제조공정수의 증가로 Cost 향상 우려</td></tr>
<tr><td>Buried Inductor</td><td>Inductor를 PCB내 Embedded 하는 개발은 아직 미진한 상황임.</td></tr>
</table>

[그림9] Embeded PCB 개발동향



LSI 및 수동부품 표면실장	수동부품 기판내장	LSI, 수동부품 모두 내장
~ 2003년	~ 2005년	~ 2010년

[그림10] Embeded PCB 기술발전 추이

8.Embedded Passive_Buried Capacitor Material

	Organic Laminates				Coated Ink	
Maker	Sanmina	DuPont	Gould	Matsushita	Asahi	Motorola
Trademark	BC-2000	Hik	TCC	Condenser Film	CX-16	Mezzanine
Materials	FR-4	$BaTiO_3$ In Polyimide Cast on Copper foil	Polyimide film	$BaTiO_3$ Dispersed In epoxy resin	$BaTiO_3$ Dispersed In epoxy resin	CFP (Ceramic Filled Photo-dielectric)
Dk (@1GHz)	4	12~20	3.2	40	60	20
Capacitance	0.5 nF/in^2	1.5 nF/in^2	1.450 nF/in^2	10~22 nF/in^2	8.5~22 nF/in^2	11nF/in^2
tanδ(1GHz)	0.021	0.01	0.009	-	0.06	0.03
Thickness	50 ㎛	8~25 ㎛	12.5 ㎛	10 ~ 30 ㎛	12~ 40 ㎛	11 ㎛
Remark	Commercially available technology High Royalty	Low breakdown Voltage High capacitive Density				Ibiden WUS AT & T

8.Embedded Passive_ Buried Resistor Material

	Screen Printable type		Thin film Laminates type		
Maker	Asahi(TU-XX-08) /Electra Polymer	DuPont	Shipley (Insite Resistor)	Gould (TCR)	Omega-Tek (Ohmega-Ply)
Materials	Conductive Carbon/Silver filled polymer pastes	LaB_6 based film (ceramic paste)	Pt thin film (Etched by Desmear Soln)	Conductor laminate film (NiCr or NiCrAlSi)	Conductor laminate film (NiP)
Resistance	1~ 1MΩ/square	10~ 10kΩ/square	10 ~ 1MΩ /square	25, 50, 100, 250 Ω/square	25, 50, 100, 250 Ω/square
Remark					