Semiconductor industry in JAPAN

Kenji Yoshino

May, 2011
Agenda

Semiconductor
- Electronics Circuit board
  - iPhone
  - PC mother board
- Semiconductor packages
  - BGA, QFP, SOP PGA, LGA
  - Package materials
- Raw material supplier
  - Resin
  - PCB
  - Mold compound
  - BT resin
- Manufacturing site
  - Electrotechno (Mitsubishi Gas Chemical)
  - Sumitomo Bakelite
  - Hitachi Chemical
  - Tanaka Denshi
- Movements
  - PCB raw material suppliers
Electronics circuit board

- Iphone components

- BGA package
- QFP package
- SOP package
Electronics circuit board

- PC mother board

- QFP package
- BGA package
- LGA package (CPU)
Semiconductor package

- **BGA** (plastic Ball Grid Array)
  - Include FC-BGA (Flip chip BGA)
  - Mainly used for high density LSIs such as CPU or System LSI ASICs.
  - Pin count from 256 to 1024 (typical, except CSP)

- **QFP** (Quad Flat Package), **SOP** (Small Outline Package)
  - From mid to low density LSI, such as analogue interface and power controller LSIs.
  - Pin count from 24 to 512 (typical)
Semiconductor package

**packages**

- **PGA** (plastic Pin Grid Array)
  - Mainly used for high density LSIs such as CPU or System LSI.
  - Pin count from 256 to 1024 (typical, except CSP)

- **LGA** (Land Grid Array)
Semiconductor package

BGA Package materials

<table>
<thead>
<tr>
<th>Part #</th>
<th>Name</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>WF</td>
<td>Die</td>
<td>Electrical circuit on Silicon Wafer</td>
</tr>
<tr>
<td>DA</td>
<td>Die Attach Adhesive</td>
<td>Conductive Silver paste</td>
</tr>
<tr>
<td>MC</td>
<td>Molding Resin</td>
<td>Resin, Plastic</td>
</tr>
<tr>
<td>Ss</td>
<td>PCB Substrate</td>
<td>BT resin, copper foil</td>
</tr>
<tr>
<td>SB</td>
<td>Solder Ball</td>
<td>Tin alloy</td>
</tr>
<tr>
<td>BW</td>
<td>Bonding Wire</td>
<td>Gold wire</td>
</tr>
<tr>
<td>MI</td>
<td>Marking Ink / LASER</td>
<td>Ink or LASER marking</td>
</tr>
</tbody>
</table>

![Diagram of BGA Package materials]

![FCP BGA Cross Section]

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Semiconductor package

QFP (Quad Flat Package) Package materials

<table>
<thead>
<tr>
<th>Part #</th>
<th>Name</th>
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<tr>
<td>WF</td>
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<td>Die Attach Adhesive</td>
<td>Conductive Silver paste</td>
</tr>
<tr>
<td>MC</td>
<td>Molding Resin</td>
<td>Resin, Plastic</td>
</tr>
<tr>
<td>LF</td>
<td>Lead Frame</td>
<td>Copper, iron alloy</td>
</tr>
<tr>
<td>BW</td>
<td>Bonding Wire</td>
<td>Gold wire</td>
</tr>
<tr>
<td>MI</td>
<td>Ink</td>
<td>Ink or LASER marking</td>
</tr>
</tbody>
</table>
Semiconductor package

LGA Package Sideview

- Die
- Bonding Wire
- Pads
- Interposer (BT resin)
## Raw material supplier

<table>
<thead>
<tr>
<th>Material</th>
<th>Supplier</th>
<th>Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wafer</td>
<td>TSMC, Shin-Etsu, MEMC, SUMCO</td>
<td>◯ (50%)</td>
</tr>
<tr>
<td>Die</td>
<td>TSMC, UMC, Renesas, Toshiba,</td>
<td>X (Automotive)</td>
</tr>
<tr>
<td>Die attach adhesive</td>
<td>Ablestik Lab.(Henkel), Hitachi Chemical, Sumitomo Bakelite</td>
<td>◯ (30%)</td>
</tr>
<tr>
<td>Mold resin</td>
<td>Sumitomo Bakelite, kyocera chemical, Hitachi chemical, Nitto denko, Panasonic, Huawei electronics (Taiwan)</td>
<td>◯</td>
</tr>
<tr>
<td>PCB</td>
<td>substrate:mitsubishi gas chemical</td>
<td>X (90%)</td>
</tr>
<tr>
<td>Solder resist</td>
<td>Taiyo ink</td>
<td>⊗</td>
</tr>
<tr>
<td>Bonding wire</td>
<td>Tanaka denshi, Kulicke &amp; soffa, Nippon micrometal mining</td>
<td>⊗</td>
</tr>
</tbody>
</table>

Die = electrical circuit on the wafer
Resin

- **Printed circuit board**
  - Glass epoxy Copper Clad Laminates
  - Glass composite Copper Clad Laminates
    - **FR-4**: Epoxy based (Frame retardant epoxy)
    - **FR-5**: fluorocarbon based resin
    - **BT resin**: bismaleimide resin, a kind of thermosetting resin

- **Application**
  - **FR-4**: mainly used for Note PC, Digital equipments, communication equipments.
  - **BT resin**: Only used for a IC Package substrate
    ("BT resin" is a trade mark of MGC)

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**Resin type (WW market, 2002)**

<table>
<thead>
<tr>
<th>Resin</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-4</td>
<td>94</td>
</tr>
<tr>
<td>FR-5 (include FR-6)</td>
<td>4</td>
</tr>
<tr>
<td>BT resin</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**Application (WW market, 2003)**

<table>
<thead>
<tr>
<th>use</th>
<th>Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi layered board</td>
<td>50</td>
</tr>
<tr>
<td>Multi material</td>
<td>33</td>
</tr>
<tr>
<td>Double sided board</td>
<td>15</td>
</tr>
<tr>
<td><strong>IC package</strong></td>
<td><strong>2</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Fuji Chimera R
PCB

- PCB materials
  - High Tg/High temperature resistance
  - General purpose FR-4
  - Build-up
  - Package
  - Composite
  - High frequency use
  - Other

- **Smart-phone and cell-phone PCB**
  Mitsubishi Gas chemical hold 50% and Hitachi Chemical hold 40% of worldwide **smart-phone and cell-phone PCB** material share.
### PCB : Raw material and the general name

<table>
<thead>
<tr>
<th>Basic raw material</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper phenolic circuit board material</td>
<td>Bakelite, XPC, FR-1</td>
</tr>
<tr>
<td>Paper epoxy circuit board material</td>
<td>Paper epoxy, FR-3</td>
</tr>
<tr>
<td>Glass epoxy Copper Clad Laminate</td>
<td>Glass fiber, FR-4</td>
</tr>
<tr>
<td>Glass composite Copper Clad Laminate</td>
<td>Glass fiber, CEM-3</td>
</tr>
<tr>
<td>Metal</td>
<td>Aluminum substrate</td>
</tr>
<tr>
<td>Ceramic</td>
<td>Ceramic substrate</td>
</tr>
<tr>
<td>Polyimide</td>
<td>Flexible substrate</td>
</tr>
</tbody>
</table>
Mold resin

Market share

Sumitomo Bakelite 40%
Nitto Denko 25%
Hitachi Chemical 14%
Toshiba Chemical 8%
Other 13%

*Include overseas manufacturing site
BT resin

Only Used for LSI package substrate board:
Package type: BGA (include FC-BGA), LGA P-PGA

• Supplier
  □ Mitsubishi Gas Chemical (MGC), Electro-techno
    (affiliated company of MGC)
  □ Hitachi Chemical
  □ Panasonic Electric Works
Manufacturing site

- **BGA package substrate board (BTresin)**
  - Electro-techno (MGC) : Saigocho-T, Fukushima

- **BGA package material (Other)**
  - Sumitomo Bakelite : Utsunomiya (Under-fill)

- **Mold resin**
  - Hitachi Chemical : Shimodate Ibaraki
  - Nitto Denko : Kameyama Mie
  - Sumitomo Bakelite : Kyushu, Singapore, Suzhou, Taiwan
  - Panasonic EW : Ayuthaya Thailand, Shanghai

- **Glass-Epoxy (Printed circuit board material)**
  - Hitachi Chemical Electronics : Mooka Tochigi
  - Sumitomo Bakelite : Fujieda Shizuoka, Malaysia
  - Panasonic EW : Japan, Taiwan, Guangzhou, Suzhou, EU
LSI Package MGF’ site, Japan
BT resin MFG’ site
Electro-techno Co. Ltd (MGC)

- 3/11: Plant facilities were destroyed due to the earthquake.
- 3/18: Infrastructure (electricity, water, others) was restored.
- 3/23: It began to ship a part of the stock.
- 4/Beginning: Partially started the manufacturing.
- 4/Beginning: The production of the BT resin is scheduled to be produced so far.
Sumitomo Bakelite

- Utsunomiya Plant (Utsunomiya, Tochigi)
  - 3/12: The production facility of the semiconductor wafer court resin suffered damage.
  - Damages were received to the production facility of the die bonding paste (negligible).

Correspondence situation
- The semiconductor wafer coat resin will be manufactured in Kyushu Sumitomo Bakelite Co., Ltd. of our group (Nogata City, Fukuoka).
**Hitachi Chemical**

**Hitachi Chemical Shimodate**

- There is a possibility that the influence goes out to operate including the product that resumes production in the future because the influence of the beginning periodical power failure is started from 3/14.
  - **Glass epoxy Copper Clad Laminates (for Cell-phone application)**
    - 3/16: The manufacturing base in the Ibaraki Prefecture west district and the Chiba prefecture restarted the supplies such as electricity, the gas, and water. Production and the shipment are scheduled to be restarted from the product (in circuit connection film (ACF) for the display, the copper-clad laminate for the printed circuit board, and partially die bonding material, the self-adhesive film, and the car application materials) one by one.
    - 3/25: Production and the shipment were restarted from the ACF, copper-clad laminate printed circuit board, the die bonding material for the semiconductor, the self-adhesive film, the molded piece for the car, the epoxy encapsulant for semiconductor, the powdery metallurgy product, and the printed circuit board, one by one.
  - **Solder resist, Die-bond, Poly amide, CMP**
    - 3/16: Manufacturing site of Hitachi district, Kashima district of Ibaraki Prefecture and Tochigi Prefecture Operation has not been restarted because enough supplies of the electric power, water, and the gas, etc. cannot be secured. The shipment of a part of stock of finished goods was restarted.
    - 3/25: Regular production and shipment were resumed for some of the products, including Anisotropic Conductive Film (ACF), Copper-clad Laminates for Printed Wiring Boards, a part of Die Bonding Materials, Adhesive Film, Interior and Exterior Plastic Molded Products for Automobiles, which we confirmed that these production lines have already recovered.
    - 3/28~: we will gradually expand the scale of the production as it becomes ready, and shipment will be also resumed. In addition to the above products, production of Carbon Anode Materials for Lithium Ion Batteries used in environmentally-friendly automobiles, Printed Wiring Boards and etc. are expected to restart partially next week as well.

An official announcement made by Hitachi chemical on March 25 and April 5.
Tanaka Denshi

- Bonding wire (gold):
  - Tanaka Denshi Kogyo (Yoshinogasato Saga, Singapore, Hangzhou, Malaysia) : The Tohoku diserster did not influence for production.
  - Kulicke& Soffa : There is no production plant in Japan.
## Movements (Possibility)
### PCB raw material suppliers

(Quantity base:%)

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Share</th>
<th>Resin (for Multi layered PCB)</th>
<th>Possibility</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isola</td>
<td>29%</td>
<td>Yes</td>
<td>○</td>
<td>EU, Asia, US</td>
</tr>
<tr>
<td>Nanya</td>
<td>20%</td>
<td>No</td>
<td>△</td>
<td>Taiwan</td>
</tr>
<tr>
<td>Panasonic</td>
<td>12%</td>
<td>Yes</td>
<td>○</td>
<td>Japan, China, Taiwan, EU</td>
</tr>
<tr>
<td>Panasonic</td>
<td>12%</td>
<td>Yes</td>
<td>○</td>
<td>Japan, China, Malaysia, Taiwan, EU</td>
</tr>
<tr>
<td>Hitachi Chemical</td>
<td>10%</td>
<td>Yes</td>
<td>○</td>
<td>Japan, China, Malaysia, Taiwan, EU</td>
</tr>
<tr>
<td>Hitachi Chemical</td>
<td>10%</td>
<td>Yes</td>
<td>○</td>
<td>Japan, China, Malaysia, Taiwan, EU</td>
</tr>
<tr>
<td>Other</td>
<td>29%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sumitomo Bakelite</td>
<td></td>
<td>Yes</td>
<td>○</td>
<td>Japan, Macau</td>
</tr>
<tr>
<td>Mitsubishi Gas Chemical</td>
<td></td>
<td>Yes</td>
<td>☀</td>
<td>Japan</td>
</tr>
<tr>
<td>Chukoh Chemical</td>
<td></td>
<td>No</td>
<td>△</td>
<td>Japan, China</td>
</tr>
<tr>
<td>Arlon MED</td>
<td></td>
<td>Yes</td>
<td>○</td>
<td>USA, China</td>
</tr>
</tbody>
</table>

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Silicon Wafer sales

Silicon Wafer sales 2007

- Shin-Etsu: 32%
- SUMCO: 21%
- TECHXIV: 8%
- Siltronics: 15%
- MEMC: 10%
- Siltronics: 15%
- Other: 14%
- MEMC: 10%
- SUMCO: 21%
- TECHXIV: 8%
Wafer manufacturer

- **Shin-Etsu (30%)**
  - 300mm (12 inch) wafer
  - Shirakawa Fukushima (Shin-estu Handoutai): damaged
  - Takasaki Gunma (Mimasu Handoutai)*
  - Chikuma Nagano (Nagano denshi)*
  - Vancouver Washington USA
    - *Manufacturing might be affected by Rolling blackout.

- **SUMCO (20%)**
  - Yonezawa Yamagata: Damaged
  - Imari Saga
  - Ehoku Saga
  - Amagasaki Hyogo
  - Asaki hyogo
  - Chitose Hokkaido
  - Noda Chiba
4/28:

1. At the Shirakawa Plant, where operations had been stopped since March 11, from April 20th we restarted partial operations. Currently, we are accelerating the work, and going forward we will increase operations gradually. We are carrying out the restoration work with the aim of returning the production capacity at the plant to the level prior to the disastrous earthquake by end of June (6) to July (7) of this year.

2. At the same time, we are coping with the current situation by increasing production operations at each of Shin-Etsu Group’s worldwide silicon wafer production sites.
SUMCO

4/22: Status of the Yonezawa Plant

- Manufacturing activity have been partially restarted using equipment for which output quality and safety have been fully confirmed.
- Recovery and restorations work which sustained damages in the earthquake has gone forward without obstructions from continuing aftershock.
- These recovery and restoration of damage buildings and equipments are scheduled to be completed by the beginning of May.
- We will carefully consider such factors as recurring aftershocks and the ability of electric power as we continue to move forward in restoring the manufacturing capacity of the Yonezawa Plant.
- To ensure the stable supplies of products, we have started backup production at other manufacturing facilities. As a result of these efforts, we expect to regain our pre-earthquake production levels in May.
MEMC

- 4/12: MEMC Utsunomiya
- The facility has been shipping unaffected product and has resumed production on qualified process tools, while continuing to inspect, qualify, and ramp additional equipment. Production yield on operating tools has been comparable to pre-earthquake levels, raw material availability has been good, and power availability has improved.
- Full 300mm production is targeted to be achieved by the middle of May. The facility's small volume of 200mm wafer capacity, previously scheduled to be moved to the company's Ipoh, Malaysia site during the third quarter of 2011, is now in the process of being moved ahead of the original schedule.