Electronic Materials Business Briefing

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I. Overview of Ajinomoto Fine-Techno Co., Inc.

II. Development of Ajinomoto Build-up Film® (ABF)

III. Electronic Materials Business Update
I. Overview of Ajinomoto Fine-Techno Co., Inc.

Founded: September 1942
Common stock: ¥315 million
Employees: 295 (as of April 1, 2019)

Functional Materials Division
- Adhesives
- Dispersing agents
- One-component epoxy resin curing agents
- Flame retardants

Electronic Materials Division
- ABF

Activated Carbon Division
- Activated carbon
- Adsorption resin
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II-1. Origin of Electronic Materials Business

Soybeans → Wheat → Glutamate → MSG

Synthesized MSG – Effective utilization of intermediate

Extraction (pre-war to early post-war)

↓

Synthesis (1960s)

Intermediate

↓

Fermentation (today)

Salt → Chlorine → Chlorinated paraffin

Epoxy resin curing agent

Led to current electronic materials business
II-2. Origin of Electronic Materials Business

Interlayer insulating material for semiconductor packaging has its origins in technology used to develop epoxy resin curing agent.

1950s
- R&D on MSG synthesis

Epox resin curing agent

1960s
- Intermediates

1999: Advent of Ajinomoto Build-up Film® (ABF), an interlayer insulating material for semiconductor packaging

Print Circuit Board (PCB)

Semiconductor package cross-section

- IC Chip
- Underfill
- C4 solder bump
- Solder resist
- Core material (FR-4 or 5)
- Dielectric Material
- PTH plugging resin
- Solder ball (2nd level interconnect)
II-3. Background of ABF’s Development

Two major turning points in latter half of 1990s:

- Ceramic ⇒ Plastic
- Wire bonding ⇒ Flip chip connection

Enabled higher-density interconnects, higher-speed signal transmission, and lighter-weight substrates, setting the stage for mass proliferation of high-performance PCs.

There was strong demand from the semiconductor industry for semiconductor packaging substrates composed of an insulating material that:

1. can easily form insulation layers of uniform thickness
2. is highly heat resistant, flame retardant, and mechanically strong when cured,
3. enables copper microcircuits to be fabricated atop insulation layers, and,
4. has a high degree of both insulation reliability and temperature cycle reliability.
II-4. Semiconductor production process in latter half of 1990s: Interlayer insulator ink used as build-up material

- Solvent odor
- Prone to residual air bubbles
- Poor surface planarity

These shortcomings were all rectified by ABF
II-5. ABF facilitates copper interconnect fabrication through plating

Plating can be applied to ABF by roughing its surface (copper interconnect fabrication through plating).
II-6. New printed circuit board manufacturing method

Build-up method
A method of manufacturing multilayer printed circuit boards by sequentially adding laminate layers, laser drilling to make vias in them, fabricating interconnects, etc.

Use of ABF enables forming fine copper pattern and, in turn, smaller devices

L/S=10/10 um
II-7. ABF’s distinguishing attributes

- World’s first film produced from liquid resin
- Easier to use than liquid materials
- Manufactured through low-waste, environment-friendly process

With our S.A.V.E. sales approach, we closely collaborate with customers from the product development stage onward after first ascertaining their true needs.

Since its launch, ABF has continuously been used by major semiconductor makers as a certified material.
II-8. Value chain

Asset-light model based on outsourcing of coating and logistics

Film converters (outsourced coating process) → ABF → Logistics companies (outsourced low-temperature distribution) → Customers

Purchasing → Varnish production → Sales → Technical support

R&D

Chemical makers → Ajinomoto Group → Suppliers related to circuit makers
  - Chemicals
  - Equipment (pre-processing, laminating, drilling, plating, etc.)

Circuit makers → CPU makers → PC makers → Consumers

Film converters (outsourced coating process)

ABF

Logistics companies (outsourced low-temperature distribution)

Customers

R&D

Suppliers related to circuit makers
  - Chemicals
  - Equipment (pre-processing, laminating, drilling, plating, etc.)

Circuit makers

CPU makers

PC makers

Consumers

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II-9. ABF manufacturing sites

- Varnish production
- Coating company
- Logistics company

Coating contractor (Niigata Prefecture)

Coating contractor (Gunma Prefecture)

Gunma Plant
- Increased production capacity
- Risk diversification

Ajinomoto Fine-Techno (Gunma Prefecture)

Ajinomoto Fine-Techno (HQ)

F-LINE Corporation
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III-1. Semiconductor market environment

Market’s long-term growth trend projected to continue

Server CPUs/GPUs and ASICs*/FPGAs** for network applications will drive market growth going forward

*ASIC: Application-specific integrated circuit
**FPGA: Field-programmable gate array

<Logic IC product market forecast>

※Rebased to 2012 = 100

※Source: Ajinomoto Fine-Techno
III-2. ABF sales

New growth phase driven by expansion to non-PC applications

1. Growth period
   2000 to 2007
   - Internet popularization
   - Rapid growth due to increasing PC demand

2. Temporary lull
   2008-12:
   - Advent of smartphones & tablets
   - PC market stagnation
   - Global financial crisis

3. New growth period
   From 2013
   - Expand into domains adjacent to the PC domain for new business growth

<Sales>
※Sales rebased to 2000 = 100

Ratio by use 2019 vs. 2013

- Other applications 61%
- PCs 39%

Based on Ajinomoto Co. research

Drastic reduction in the PC area, with growth in other areas (servers, telecommunications, etc.)
III-3: Expansion of other applications

Growth in sales for server and communication applications in conjunction with advent of 5G

Detailed breakdown of Ratio by use 2013 vs. 2019

Use of ABF for high-frequency applications
- Launching to market of ABF able to achieve low dielectric tangent
- Developing new materials able to meet customers’ needs

Forecast number of data center servers (mn units)

Cloud services market expansion is driving:
- Steady growth in number of installed data center servers
- Growth in communication infrastructure

※Source: Ajinomoto Fine-Techno
III-4. Business network expansion

Taiwan/China activity hubs
Taiso Commerce Inc. established in Taipei in 1988
Ajinomoto Shanghai Specialty Chemicals Co. Ltd. established in Shanghai in 2018

North America activity hub AFT-USA established in Silicon Valley in 2015

Space for collaboration on value creation with customers
AFT Future Creation Center established in 2016

Access to globally leading-edge information
Facility for envisioning and co-creating the future with customers
Eat Well, Live Well.

AJINOMOTO®