Atotech’s sustainable production methods and technology solutions for the semiconductor industry

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Presentation Outline

1. Atotech at a Glance
2. Atotech’s Sustainability Commitment
3. Sustainable Production for Semiconductor Applications
4. Atotech’s Turnkey Solution for Cu deposition in Semiconductor Applications
5. Summary
This is Atotech
Atotech is a leading supplier of plating chemicals, equipment and service for the printed circuit board, package substrate, semiconductor, and surface finishing industries.
Our global presence

Regional head offices with integrated R&D and TechCenter

1. Berlin, DE
2. Yokohama, JP
3. Rock Hill, US

Chemistry production (16)
Equipment production (2)
R&D center (11)
TechCenter (18)
Legal entities (33)

all data relate to 2016/03/31
Atotech – At a glance

Founded in 1993

Direct subsidiary of TOTAL S. A.

4,000 experts

Global market leader

M$ 131 allocated to research and development

1,965 total patents in our portfolio as of today

Over B$ 1.1 in sales

172 kt/year total produced chemicals

Present in 47 countries, serving > 8,000 customers worldwide

3 regional HQ
11 R&D sites
18 TechCenters
19 Production sites

all data relate to 2016/03/31
Our corporate strategy

**Best local service**
TechCenters with production-sized plating lines for qualification and training

**Leading technology**
Meeting the industries’ current and future requirements

**Production know-how**
Chemicals, systems and service solutions for the surface finishing and electronics industry

**Environmentally sound technology**
Sustainable systems and chemical processes to reduce environmental impact

**Safety**

**Sustainability**

**Compliance**
Our global semiconductor network

Atotech continually invests in its global network and service capabilities in order to best serve the semiconductor industry.
## Our semiconductor product portfolio

### Electroless Deposition
- **Chemistry**
  - Xenolyte Ni
  - Xenolyte Pd
  - Xenolyte Au

- **Processes with our chemistry**
  - Wire bonding
  - Wedge bonding
  - RDL Housing
  - Soldering

- **Customer’s application**
  - IGBT
  - Memory

- **Customer’s products & markets**
  - Car
  - Renewable energy

### Electrochemical Deposition
- **Chemistry**
  - Spherolyte Cu
  - Spherolyte Ni
  - Spherolyte Sn

- **Processes with our chemistry**
  - Pillar Plating
  - RDL Structure
  - Through Hole Filling

- **Customer’s application**
  - 3D Packaging
  - Flip Chip
  - FOWLP

- **Customer’s products & markets**
  - Mobile devices
  - Consumer electronics

### Dual Damascene
- **Chemistry**
  - Everplate Cu
  - Atomplate Cu
  - Seedplate Cu

- **Processes with our chemistry**
  - Chip Interconnections

- **Customer’s application**
  - Memory
  - Logic

- **Customer’s products & markets**
  - Computer hardware
  - Consumer electronics
Atotech’s Sustainability Commitment
Atotech’s commitment to sustainability

At Atotech, we have set a clear goal for ourselves: to be the leading supplier of sustainable plating and surface finishing systems.

• We are committed to remove toxic substances from our product portfolio
• Our systems are designed to efficiently use water, energy and raw materials, which reduces waste, and delivers greater savings for our customers

39% of our R&D projects are related to sustainable technologies
Our step-by-step approach

It is our uncompromising commitment to eliminate harmful substances from our products:

• CMR substances (carcinogenic, mutagenic and reproductive toxic)
• Toxic substances (e.g. cyanide, hexavalent chromium, nickel-compounds)
• Heavy metals (e.g. Pb, Hg, Cd)
• Allergenic substances

3,163 t reduction in toxic raw materials since 2010

10.3% of total tonnage includes problematic raw materials
## Our toxic products elimination roadmap

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Ni free e'less Copper (Horizontal)</td>
</tr>
<tr>
<td></td>
<td>New acid cleaners (boron free)</td>
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<tr>
<td></td>
<td>Introduction of fluoride free Metal Strippers</td>
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<td></td>
<td>Introduction of solvent free Silanes</td>
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<td></td>
<td>Introduction of MeOH free Passivation</td>
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<tr>
<td>2013</td>
<td>Formaldehyde free e'less Copper</td>
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<tr>
<td></td>
<td>Decarbonator</td>
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<tr>
<td></td>
<td>Replace Biocides in Acid Cleaners</td>
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<tr>
<td>2014</td>
<td>Ni free e'less Copper (Vertical)</td>
</tr>
<tr>
<td></td>
<td>Formaldehyde Alternatives as Biocide (with other BTTs)</td>
</tr>
<tr>
<td></td>
<td>New acid cleaner (NPE + PFOS free + biodegrad.)</td>
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<tr>
<td></td>
<td>Metal stabilizer-free e'less Ni</td>
</tr>
<tr>
<td>2015</td>
<td>Introduction of NEAP Alternatives replacing Thiourea</td>
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<tr>
<td></td>
<td>Cyanide free immersion gold bath alternatives to Nickel as a diffusion barrier</td>
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<tr>
<td>2016</td>
<td>Screening of Borane free Reducer</td>
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<td></td>
<td>Introduction of TMAH free Resist Strippers</td>
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<td></td>
<td>DMF-free Cleaner Additive</td>
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<td>2017</td>
<td>Screening of alternatives to Sodium Chlorite</td>
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<td>Non toxic desmear reduction</td>
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<td></td>
<td>Boron Free Reducer for Uniplate</td>
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<tr>
<td>2018</td>
<td>Boric acid free adhesion promoter for Ecopact based processes</td>
</tr>
<tr>
<td></td>
<td>Non toxic Stabilizers</td>
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<tr>
<td></td>
<td>Boric Acid free ionic Activator</td>
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</tbody>
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Status April 2016

NPE: Nonylphenol ethoxylates, NMP: N-Methyl-2-pyrrolidone, PFOS: perfluorooctane sulfonate, NEAP: Non-Etching Adhesion Promoter, TMAH: Tetramethylammonium hydroxide
More efficiency in a sustainable way

Complementing our environmentally responsible chemical products, we offer auxiliary and production systems to further support sustainable production aims:

- Less consumption of raw materials
- Less waste
- Higher efficiency

Oxamat and Redumat
Our sustainable technologies

Formaldehyde-free and Cyanide-free E’less Cu
- Consequent elimination of harmful chemicals: HCHO, Ni, CN, P
- Biodegradable complexing agent
- Excellent coverage without blistering on a wide range of base materials
- Flexible deposition rate of 0.5-0.9 μm in 20 min
- Excellent bath stability

Cu regeneration and replenishment system
- Continues regeneration of etching solution
- Copper recovery
- Significantly less waste, minimizes waste over 90%
- Lower production costs

Additive for reduced Reducer consumption for E’less Cu process
- Minimizes the self decomposition of reducer chemistry
- Up to 30% savings in reducer chemistry
- Up to 30% savings in boron content in waste water
- Mainly for horizontal application
Sustainable Production for Semiconductor
Sustainable production – equipment

Atotech manufactures the innovative MultiPlate plating system in our cleanroom production facility.

- Latest engineering manufacturing technologies
- Sustainable production methods
- Class 7 cleanroom and ISO 14001 Certified

MultiPlate automated system production

Equipment production in Feucht, Germany

5.5M€ investment in manufacturing hall + tools

2,250m² cleanroom equipment production area
Sustainable production - equipment

- Recycling of Materials
  - Plastic, PVC, Stainless Steel, etc.

- Heat Recovery System
  - 70% Energy Regeneration

- Recycling of Chemistries
  - Cleaning and Rinsing Chemistries

ISO 14001 certified
Atotech manufactures high purity chemistries in our state of the art cleanroom production facility.

- Latest engineering manufacturing technologies
- Advanced filtration and automation
- Sustainable production methods
- ISO 9001 & 14001 Certified

1,500 m² cleanroom production area
Sustainable production – high purity chemistry

1. Chemistry Distribution System
   - Ultra Pure Water Inlet
   - Mixing and Recirculation loop
   - Filtration
   - Dosing Pump
   - Raw Material

2. Mixing Vessel
   - Gas Exhaust Apparatus
   - Weighing Unit
   - Mixing and Recirculation loop
   - Filtration
   - Dosing Pump

3. Filling Station
   - Conveyor
   - High Purity Drum
   - Clean Room Mini Environment

ISO 14001 Certified
Heat Recovery System
Optimized Vessel Rinsing
Closed Production Systems
Precious Metal Recycling
Waste Water Recycling
Our Turnkey Solution for Cu Deposition in Semiconductor Applications
MultiPlate – a next generation packaging tool

Compatibility:
• Single and double sided applications
• 150, 200, 300 mm wafer
• Taiko thin wafers
• Panel sizes up to 510 x 510 mm
• Various electrolytes
• Variety of substrate materials

Target Applications:
• THF: Through hole filling
• DSP: Double side plating
• RDL: Redistribution layer
• Cu pillar (standard & tall)
MultiPlate – a next generation packaging tool

Advanced fluid flow delivery

Segmented, stable anodes

Pulse plating capability

Free programmable agitation

Cu replenishment system

Modular design
MultiPlate – a next generation packaging tool

Cu replenishment system **PATENTED**

- Oxidizes metal Cu to Cu2+ ions in Cu dissolving unit
- Stabilizes active stage of Accelerator compound via metal Cu

Advantage:

- Prevents oxygen gas evolution (bubbles) at anode, thereby enabling:
  - **Lower consumption of additives (no oxidation)**
  - **Longer and more stable bath life**
  - Minimized surface defects (no mixed oxide particles)
  - Two additive system, without leveler
- Dimensionally stable anodes enable:
  - No change in anode to cathode distance
  - Significantly reduce anode maintenance time
MultiPlate – a next generation packaging tool

- Low process temperature,
  while maintaining:
  - High current density
  - Optimal uniformity
  - Highest purity of Cu
Summary
Sustainable semiconductor production and processes

- Committed Sustainability Roadmap for Chemistry and Equipment
- Heat Regeneration during Equipment and Chemistry Production
- Optimized Rinsing and Cleaning; Recycling of Cleaning Chemistries
- Recycling of all Materials used in Equipment Production
- Enclosed Chemistry Production Environments
- Unique MultiPlate Process Features for Sustainable Processing