ULTRA-FINE METAL POWDERS FOR A WIDE RANGE OF MICROELECTRONIC ASSEMBLIES

5N Plus Inc., Micro Powders
Montreal, Canada

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Outline

• Introduction
• Description of 5N Plus atomising technology
• Key characteristics of 5N Plus’ powders
• Powders for microelectronic packaging
• Summary
WHO ARE WE & WHAT DO WE DO?

WE DEVELOP, MANUFACTURE & SELL ADVANCED & ENGINEERED MATERIALS ESSENTIAL FOR CRITICAL INDUSTRIES.

We close the loop of critical consumables in our products to make our business model sustainable.
Micro Powders

5N Plus Footprint

- Oil and Gas
- Yellow Pigment for Paint
- Solar Panels
- Industrial Alloys
- Airport Security Infrared Imaging
- Active Ingredient in Antacids
- Medical Imaging
- Earth Imaging
- Satellite Solar Arrays
- Consumer Electronics
- Internet 5G
- Gold Jewelry
- Animal Feed Additives

Enabling Performance
5N Plus acquired a unique atomization technology for the manufacture of ultra-fine metallic powders.

Construction of high-performance powder production plant in Montreal

Commissioning of new facility in Montreal completed.

Low temp alloy and solder powders available.

Low alpha powder production implemented.

High-temperature atomization capability installed (~1200°C).

Ultrafine powders (Types 9 & 10) available.
Proprietary atomization

1. Liquid metal is poured into the atomizing chamber through a proprietary metal delivery nozzle.
2. A proprietary atomizing nozzle delivers a supersonic inert gas flow that converges to the liquid metal stream.
3. The supersonic gas break-up the metal liquid stream into fine particulates that solidify in the form of spherical particles.
4. The powder is transferred to a unique classification process.

5N Plus Technology

<table>
<thead>
<tr>
<th>Conventional Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 3</td>
</tr>
<tr>
<td>Type 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5N Plus Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 5</td>
</tr>
<tr>
<td>Type 6</td>
</tr>
<tr>
<td>Type 7</td>
</tr>
<tr>
<td>Type 8</td>
</tr>
<tr>
<td>Type 9</td>
</tr>
<tr>
<td>Type 10</td>
</tr>
</tbody>
</table>
Atomized Powders

Wide range of alloys and melting points:
The technology is perfectly adapted for metal and alloys having melting point ranging from 60 to ~1200°C.
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Tight surface chemistry control

Process allows to **tightly control the oxide layer** at the surface of the particles.

- AES - Depth profile - Level 1
  - 3 nm oxide layer

- TEM
  - Very thin and uniform oxide layer
  - 3.4 nm

- EDS Oxide layer
  - Sn, Al, Au, Ga, Si

- SAC305 powder particle
  - 10 nm
Superior Reflow Performance

**Solder Ball Test**

1. Printing solder paste

2. Reflowing at 25°C higher than melting point: Sn-Ag-Cu (SAC305)

**Cross Wetting Test**

1. Printing solder paste

2. Reflowing at 25°C higher than melting point:
5N Plus Products for Microelectronic packaging

Surface Mount Technology

Semiconductor Packaging

Mini-LED and Micro-LED packaging

Printed Electronics
Various Particle Size Distributions

Particle size distribution (PSD) of 5N Plus powders

- T10 Powder
- T9 Powder
- T8 Powder
- T7 Powder
- T6 Powder
- T5 Powder

Surface Mount Technology
Semiconductor Packaging
Mini & Micro LED Packaging
Printed Electronics
Powders for Surface Mount Technology

- **Stencil printing**: the solder paste rolls on the stencil and flows into stencil apertures.

- **Dispensing**: the solder paste is pushed to flow through a narrow needle.

- **Jet printing**: the solder paste is projected dot by dot at high speed on the substrate.

- **5N Plus provides customized particle size**:
  - To enhance *paste transfer efficiency* for stencil printing
  - To enhance *rheology and flow* of pastes for dispensing and jet printing machines
Powders for Semiconductor Packaging
Low Alpha Count Powders

- Sn-Ag-Cu
- Sn-Ag
- Sn-Cu
- Sn-Bi (+Ag)

Type 5 to Type 8

ULA: $< 0.002 \text{ c/h/cm}^2$
SULA: $< 0.001 \text{ c/h/cm}^2$

Prevent soft error in chips by eliminating alpha ray emission from the solder materials.
Powers for Semiconductor Packaging
Transient Liquid Phase Sintering (TLPS)

- TLPS inks/pastes for high temperature resistant application
- Tuning particles size and alloying chemistry lead to the best performance.

Cu-based powder + Sn-based powder

After reflow at 270°C

Sn X-ray mapping
Cu X-ray mapping

IMC (Cu-Sn)
Melted Sn
Powders for Mini-LED and Micro-LED assembly

- **Mini-LED and Micro-LED** are emerging flat-panel display technologies. Displays consist of arrays of fine and ultrafine LEDs.

- **Packaging** of very fine LEDs have been recognized as one of the main challenges.

- **Anisotropic Conductive Adhesives (ACA):**
  - Anisotropic Conductive Film (ACF)
  - Anisotropic Conductive Paste (ACP)

*Ultrafine metal particles enable reliable electrical connections*
New Products for Mini & Micro-LED assembly
Type 9 Powders (3.5 µm)

- PSD
  - $D_{10}$: 2 µm
  - $D_{50}$: 3.5 µm
  - $D_{90}$: 5 µm

- Very low oxygen content: ~1000 ppm
- High purity: >99.95% (3N5)

- Sn-Ag-Cu
- Sn-Ag
- Sn-Cu
- Sn-Bi
- Sn-Bi-Ag

Commercially available now!
New Products for Mini & Micro-LED assembly
Type 10 Powders (2 µm)

- PSD
  - $D_{10}$: 1 µm
  - $D_{50}$: 2 µm
  - $D_{90}$: 3 µm

- Very low oxygen content: ~1500 ppm
- High purity: >99.95% (3N5)

Commercially available now!
- Sn-Ag-Cu
- Sn-Ag
- Sn-Cu
- Sn-Bi
- Sn-Bi-Ag
Powders for Printed Electronics
Conductive Inks

- Low melting point based conductive inks
- Ultrafine powders T9 (3.5 µm) and T10 (2 µm)
- Fast sintering (< 1 min)
- Sheet Resistivity down to 25 mΩ/sq
- Stable conductivity in long service condition
Summary

• Proprietary atomizing technology which is capable to produce powders with:
  – Fine particles and narrow size distribution
  – High sphericity
  – Low and controlled oxygen content

• Four applications were discussed:
  – Surface Mount Technology
  – Semiconductor packaging
  – Mini-LED and Micro-LED packaging (ACF/ACP)
  – Printed electronics
Ultra-Fine Metal Powders for a Wide Range of Microelectronic Assemblies

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Visit us at booth# I-2404