PREP powder, better for Metal AM
～デジタルものづくり・金属積層工法に理想的な原料粉末（PREP粉末）～
### Corporate Profile

<table>
<thead>
<tr>
<th>Name</th>
<th>JAMPT Corporation</th>
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<tbody>
<tr>
<td><em>Japan Additive Manufacturing &amp; Processing Technology</em></td>
<td></td>
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<tr>
<td>Established</td>
<td>October 18, 2017</td>
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<tr>
<td>Capital</td>
<td>JPY 955 million (Capital: 482 million, Capital Reserve: 472 million) / Approx. US $ 8.6 million</td>
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<td>Shareholder</td>
<td>Sojitz (56%), Koiwai (34%), Tohoku University (10%)</td>
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<tr>
<td>CEO</td>
<td>Noritaka Yasuda (from Sojitz)</td>
</tr>
<tr>
<td>Location</td>
<td>3-8, Ipponyanagi, Tagajo-shi, 985-0874, Miyagi-ken, Japan</td>
</tr>
<tr>
<td>Business</td>
<td>Total Solution Provider for Metal AM (3D printing)</td>
</tr>
</tbody>
</table>

**Miyagi Factory (HQ)**

- **Start operation:** Aug 10, 2018

**Contact Information:**

- **E-Mail:** [komatsu.nobuhiro-2@sojitz.com](mailto:komatsu.nobuhiro-2@sojitz.com)
- **Tel:** +81-80-8733-4811
- **E-Mail:** [takahashi.mitsuya@jampt.jp](mailto:takahashi.mitsuya@jampt.jp)
- **Tel:** +81-22-290-0630
Additive Manufacturing
- Prototyping
- Commercial Production
- Design Optimization (future)
- Post Processing (future)

Material Powder
- PREP powder development, production & marketing
- Development of Metal Powder / New Materials with Tohoku Univ.

Printer Development
- In close collaboration with Japanese AM Machine manufacturer

Sponsoring TUfast Racing Team, TU Munish, and supply AM parts (Housing)

Joined Mobility goes Additive (MgA), the leading international AM industrial network
What is PREP?

- PREP is one of the most advanced technologies for metal powder production and is suitable for additive manufacturing due to its characteristics of high-sphericity, no gas contents, no satellites, no contamination.

- PREP powders have a very high internal density because the molten metal is pulled off the bar surface by centripetal acceleration so there is no entrapped gas in particles.

- JAMPT’s PREP production is supervised by Prof. Akihiko Chiba of Tohoku University, Japan’s most known university/laboratory for metallurgy.

- JAMPT’ PREP machine rotates 300mm x 70mm electrode at 20,000rpm, gives particle size of 30-100μ.

PREP equipment in JAMPT@Miyagi
Technical issue in using existing powder for AM (1)

Gas atomization (VIGA, EIGA)

[Reference] AP&C

Gas Atomized powder tend to have **low sphericity**, **much satellite** and **gas porosity**.

Gas inclusion is inevitable due to its production process.
Plasma-atomized powder is superior in quality (Sphericity and less Satellite) than Gas-atomized powder but **still contains a certain amount of gas porosity**. It’s also inevitable due to its production process.
Technical issue in using existing powder for AM (3)

Mechanism of gas pore remains in AM process

Gas porosities contained in material powder doesn’t disappear but transfers to the components during the AM process.

Comparison of gas porosities at AM sample (EBM / Ti6Al4V)

- Many gas porosities are observed in “As-built” and “Heat Treated(HT)”
- No gas porosity is observed after “HIP”
- Gas porosities come from powder

Fatigue Test

- During fatigue test, crack initiation occurred from surface for “As-built” and “HT”
- Crack initiation occurred from internal for “HIP”
- “HIP” material broke at 8.7M cycles at 600MPa.

[Reference] Prof. Akihiko Chiba / Chiba Laboratory of Deformation Processing, Institute for Materials Research, Tohoku University
Visualization of the porosity (in **Red**) imaged by CT scans of the same cylindrical sample.

- Porosity disappears after HIP, but does regrow under the condition of high temperature.
- HIP is costly and not a perfect solution especially for the application where high fatigue strength is required.

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[Reference] S. Tammas-Williams a, P.J. Withers b, I. Todda, P.B. Prangnell b
a Department of Materials Science and Engineering, University of Sheffield, Sheffield S1 3JD, UK
b School of Materials, University of Manchester, Manchester M13 9PL, UK
CPS requires ideally spherical powder, PREP could be

**Powder**

- Powder properties
- Layer thickness
- Bulk density etc.

**Fusion**

- Convection
- Evaporation
- Heat transfer
- Mass transfer etc.

**Microstructure**

- Temperature gradient
- Solidification speed etc.

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### Parameter for AM process simulation

**【Powder bed】**
- Powder properties
- Layer thickness
- Bulk density etc.

**【Hydrodynamics】**
- Convection
- Evaporation
- Heat transfer
- Mass transfer etc.

**【Solidification】**
- Temperature gradient
- Solidification speed etc.

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**Spherical powder**

Process simulation for AM

Establish CPS

※ CPS : Cyber Physical System

[Reference] Prof. Akihiko Chiba / Chiba Laboratory of Deformation Processing, Institute for Materials Research, Tohoku University
JAMPT’s PREP powder (1)

Comparison with other powders

<table>
<thead>
<tr>
<th></th>
<th>JAMPT’s PREP powder</th>
<th>Plasma Atomized (in general)</th>
<th>Gas Atomized (in general)</th>
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</thead>
<tbody>
<tr>
<td>Sphericity</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Gas Porosity</td>
<td>Zero</td>
<td>Limited</td>
<td>More</td>
</tr>
<tr>
<td>Satellite</td>
<td>Very Limited</td>
<td>Some</td>
<td>More</td>
</tr>
<tr>
<td>Flowability</td>
<td>High</td>
<td>Medium</td>
<td>Less</td>
</tr>
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Powder Image (1) vs. Powder Image (2)

Sectional view (SEM) of JAMPT’s PREP powder: No gas porosity is can be observed.

- JAMPT’s PREP technology provides superior powder quality than other technology.
- Materials JAMPT offers by PREP is Ti6Al4V, Inconel 718, TiAl.
  *Continuing to develop other materials
JAMPT’s PREP powder （2）

- JAMPT’s PREP powder is high in flowability which enables smooth spread of powder on build stage and more accurate production.
- High sphericity enables powder users more close-to-reality input to the simulation software, resulting more accurate / trustworthy simulation result.

<table>
<thead>
<tr>
<th>Powder Type</th>
<th>Repose Angle</th>
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<tbody>
<tr>
<td>PAMPT’s PREP Powder</td>
<td>28.4°</td>
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<tr>
<td>Gas Atomized Powder</td>
<td>34.3°</td>
</tr>
</tbody>
</table>

※ Repose angle: When dropping powder onto the stage, powder with high sphericity creates lower angle of repose.
Vielen Dank!!