Neutron Absorber

Maxus®

NRC PUBLIC MEETING WITH NUCLEAR INDUSTRY VENDERS
Rockville, MD
March 14, 2013
Kazuto Sanada

Nippon Light Metal Company, Ltd., Tokyo, Japan
Nikkeikin Aluminium Core Technology Company, Ltd., Tokyo, Japan
1. Corporate Profile
2. What is MAXUS®
3. Manufacturing Process
4. Quality Control
5. Testing
6. Application
7. Operating Experience
8. Material Properties
# 1. Corporate Profile

<table>
<thead>
<tr>
<th></th>
<th>Nippon Light Metal Holdings Co., Ltd.</th>
<th>Nikkeikin Aluminium Core Technology Co., Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headquarters</td>
<td>Tokyo, Japan</td>
<td>Tokyo, Japan</td>
</tr>
<tr>
<td>Established</td>
<td>October 1, 2012</td>
<td>October 1, 2002</td>
</tr>
<tr>
<td>Capital</td>
<td>476 Million US$</td>
<td>5.6 Million US$</td>
</tr>
<tr>
<td>Sales</td>
<td>4,903 Million US$</td>
<td>393 Million US$</td>
</tr>
<tr>
<td>Employees</td>
<td>10,041 Persons</td>
<td>900 Persons</td>
</tr>
</tbody>
</table>

1) URL: [http://www.nikkeikinholdings.com/](http://www.nikkeikinholdings.com/)
2) URL: [http://www2.nikkeikin.co.jp/act/](http://www2.nikkeikin.co.jp/act/)
3) and its Consolidated Subsidiaries
4) in the term ending in March 2012
1. Corporate Profile

Nippon Light Metal Holdings Co., Ltd.

Nippon Light Metal Co., Ltd.

Nikkeikin Kakoh Kaihatsu Holdings Co., Ltd.

Nikkeikin Aluminium Core Technology Co., Ltd.

Nikkei Niigata Co., Ltd.

Nikkei Technology Center Co., Ltd.

Toyoo Aluminium K.K.

Other Companies

Nagoya Plant

Rolling of Al Plate

Other Companies

Niigata Plant

extrusion, Rolling and Others

Osaka Plant

Case Processing

Other Companies

Hino Plant

Atomizing, Blending and Others

Other Companies

Other Companies

Other Companies
1. Corporate Profile

**Aluminum Foil, Powder and Paste**
- 26%

**Aluminum Ingot and Chemicals**
- 25%

**Sales: 4,741 Million US$ (FY2011)**
- 32%
- 17%

**Fabricated Products and Others**

**Aluminum Sheet and Extrusions**

URL: [http://www.nikkeikinholdings.com/](http://www.nikkeikinholdings.com/)
2. What is MAXUS®

MAXUS is a clad material with high density and is qualified as MMC.

- Skin: A5052 (Al-Mg)
- Core: A1070 + 40wt% B₄C

A1070 + 40wt% B₄C
MAXUS is a clad material with high density and is qualified as MMC.

- No $B_4C$ particles loss from the surface because of the clad structure.

- Composed of A1070 and A5052 that have good corrosion resistance.

### Material Purity of Al

<table>
<thead>
<tr>
<th>Material</th>
<th>Purity of Al</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1070</td>
<td>$\geq 99.70%$</td>
</tr>
<tr>
<td>A1050</td>
<td>$\geq 99.50%$</td>
</tr>
<tr>
<td>A1100</td>
<td>$\geq 99.00%$</td>
</tr>
</tbody>
</table>
MAXUS is a clad material with high density and is qualified as MMC.

Skin
A5052 (Al-Mg)

Core
A1070+B₄C

- Diffusion of Mg from the Skin into the Core Al
  ⇒ Metallurgical Bond between Core and Face Skins
2. What is **MAXUS**

Grain boundary structure of between skin and core by SEM-EBSD.

(a) Low magnified image.  
(b) High magnified image.
1. Corporate Profile
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6. Application
7. Operating Experience
8. Material Properties
3. Manufacturing Process

- Rolling of Al Plate
- Case Processing
- Extrusion of Al Frame
- Atomizing of Al Powder
- Blending with B₄C
- Filling up
- Welding
- Heating
- Rolling
- Heating
- Leveling
- WJ Cutting
- Inspection
- Shipping

- Hino Plant
- Nagoya Plant
- Niigata Plant
- Osaka Plant
3. Manufacturing Process

- Rolling of Al Plate
- Case Processing

- Hino Plant
- Nagoya Plant
- Niigata Plant
- Osaka Plant
3. Manufacturing Process

Filling up Al with B₄C

Hino Plant
Nagoya Plant
Niigata Plant
Osaka Plant
3. Manufacturing Process
We control the whole process in-house from the upstream processes (powdering) to the downstream processes (rolling and cutting).

- We get the MMC grade density by rolling directly from powder.

- We assure the highest quality throughout the manufacturing process.
# 4. Quality Control

<table>
<thead>
<tr>
<th>Rules and Regulations</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>10 CFR 71 Subpart H</td>
<td>NRC</td>
</tr>
<tr>
<td>10 CFR 72 Subpart G</td>
<td>NRC</td>
</tr>
<tr>
<td>10 CFR 830 Subpart A</td>
<td>NRC</td>
</tr>
<tr>
<td>10 CFR 50 Appendix B</td>
<td>NRC</td>
</tr>
<tr>
<td>10 CFR 21</td>
<td>NRC</td>
</tr>
<tr>
<td>NQA-1</td>
<td>ANSI / ASME</td>
</tr>
<tr>
<td>NP-5652</td>
<td>EPRI</td>
</tr>
<tr>
<td>TR-017218-R1</td>
<td>EPRI</td>
</tr>
<tr>
<td>G414 1-3</td>
<td>DOE</td>
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## 5. Testing

<table>
<thead>
<tr>
<th>Typical Testing</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Durability</td>
<td></td>
</tr>
<tr>
<td>Corrosion</td>
<td>From 96 to 8,000 hours</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Tensile Test</td>
</tr>
<tr>
<td></td>
<td>Bending Test</td>
</tr>
<tr>
<td>Density and Interconnected Porosity</td>
<td></td>
</tr>
<tr>
<td>Boron Uniformity</td>
<td></td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>(ASTM E 1225)</td>
</tr>
<tr>
<td>$^{10}$B Areal Density Verification</td>
<td>Neutron Transmission</td>
</tr>
<tr>
<td>Chemical Composition Analysis</td>
<td>ICP-AES</td>
</tr>
</tbody>
</table>
5. Testing - NLM GROUP Testing Laboratory
### 6. Application

<table>
<thead>
<tr>
<th>Application</th>
<th>Customer</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutron Absorber for Dry Casks</td>
<td>USA</td>
<td>Qualified, Actually In-Use</td>
</tr>
<tr>
<td></td>
<td>JPN</td>
<td>Qualified, Actually In-Use</td>
</tr>
<tr>
<td>for Wet Storage Racks</td>
<td>USA</td>
<td>Qualified</td>
</tr>
<tr>
<td>for a Nuclear Complex</td>
<td>USA</td>
<td>Qualified, Actually In-Use</td>
</tr>
<tr>
<td>Neutron Filter for a Nuclear Complex</td>
<td>JPN</td>
<td>Qualified, Actually In-Use</td>
</tr>
<tr>
<td>Structural Material for Dry Casks</td>
<td>JPN</td>
<td>Under Development</td>
</tr>
</tbody>
</table>
6. Application

Neutron Absorber for Japan
Neutron Absorber for Oak Ridge National Laboratory

- **Diameter**: 660.4 mm (26 inches)
- **Wall Thickness**: 10 mm (0.4 inch)
- **Height**: 2146.2 mm (84.5 inches)
6. Application

For JRR-3 (Extrusion MMC Tube)  
Neutron Filter for Japan Atomic Energy Agency

For JRR-4  
(MAXUS with FSW)
7. Operating Experience

Powder Product (not Neutron Absorber)

Neutron Absorber (Structural Material)

Development

Operation

Neutron Absorber

Development

Operation

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8. Material Properties - Mechanical Properties

Tensile Strength and Elongation

![Graph showing Tensile Strength and Elongation vs. B₄C loading (wt%)](image-url)
8. Material Properties – Other Properties

Thermal Conductivity

\[ \text{Thermal Conductivity} \quad [\text{W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}] \]

\[ \begin{align*}
\text{B}_4\text{C loading} \quad \text{/wt\%} & \quad 10 & \quad 20 & \quad 30 & \quad 40 & \quad 50 \\
\text{Thermal Conductivity} & \quad 250 & \quad 150 & \quad 100 & \quad 50 & \quad 0
\end{align*} \]

\[ \text{10B Areal Density} \quad [\text{mg} \cdot \text{cm}^{-2}] \]

\[ \begin{align*}
\text{B}_4\text{C loading} \quad \text{/wt\%} & \quad 10 & \quad 20 & \quad 30 & \quad 40 & \quad 50 \\
\text{10B Areal Density} & \quad 0 & \quad 10 & \quad 20 & \quad 30 & \quad 40
\end{align*} \]

10B Areal Density (per 2.5mm Thickness)
Thank you for listening.

Aluminum is our foundation. We will use it as a springboard to new heights.