International Titanium Association
Chicago, 24 September 2014.

Titanium metal – a global perspective:
Supply/ demand and key industry drivers, threats
and opportunities.

About your presenter today

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New Strong, Light Metal Is Extracted

Titanium metal is a structural metal, never before available to industry, so that its use is the fourth most plentiful in the earth's crust next to iron, aluminum and silver. It is about as strong as steel but only one-third as dense. Titanium, its color, is a silvery-white metal which is stable in water and air. Titanium is highly resistant to chemicals and heat. While it has only the fourth highest tensile strength of all commercial metals, its density is lower than that of aluminum and it has more than twice the modulus of elasticity of steel. It is 50% more resistant to corrosion than stainless steel. More important than all this is the fact that titanium is a ductile metal, easily worked by forging, rolling, milling and other metal-working processes. A problem that is common to aluminum and other high-strength metals is that they cannot be welded. Titanium can be welded. It is also easily cast, formed and machined. It can be ground and polished to a mirrorlike finish. Titanium is as strong as steel but only one-third as dense. Its high strength-to-weight ratio makes it valuable for airplane wings, pontoons, and rudders. It is used in many commercial products, such as chemical equipment, heat exchangers, and solar collectors. It is also used in the aerospace industry for engine parts and other high-temperature applications.

Titanium is a light, strong, and corrosion-resistant metal that is highly valued in many industries. Its unique combination of strength and lightness makes it ideal for applications where weight savings are critical. In addition to its use in the aerospace industry, titanium is also used in the production of high-performance sports equipment, medical implants, and jewelry. Its versatility and durability make it a valuable material for a wide range of applications. **New Strong, Light Metal Is Extracted**

Titanium: Our Next Major Metal?

A new high-strength aluminum alloy is being developed for industrial and aircraft applications. The alloy, designated as Ti-6Al-4V, is being studied by the U.S. Bureau of Mines. It is being tested in the National Aeronautics and Space Administration's (NASA) Langley Research Center. The alloy is being tested for its strength and corrosion resistance in various environments. The alloy is expected to be used in aircraft and spacecraft components, such as fuselage panels and structural elements. It is also being considered for use in the automotive industry. The alloy is being developed by the Titanium Development Corporation, a joint venture of the U.S. Department of Energy and the U.S. Air Force. The alloy is expected to be available for commercial use in the near future. **Titanium: Our Next Major Metal?**

TITANIUM AND ITS USES

Titanium is a metal with many uses in various industries. It is used in the aerospace industry for its high strength-to-weight ratio. It is also used in the automotive industry for its corrosion resistance. It is used in the medical industry for its biocompatibility. It is also used in the chemical industry for its resistance to corrosion. Some of the uses of titanium include:

- Aircraft and spacecraft components
- Medical implants
- Chemical process equipment
- Water treatment equipment
- Dental implants

Titanium is a metal that is increasingly being used in various industries due to its unique properties. It is a metal that is expected to have a bright future in the years to come. **TITANIUM AND ITS USES**
Number of survey respondents

- Raw materials: 28
- Mill products: 27
- Other: 16
- Distributor: 14
- Fabricator: 9
- Forger: 8
- OEM: 8
- Research: 7
- External: 3

Where do you do business?

- Global: 52%
- Nth America: 25%
- W Europe: 10%
- Asia-Pacific: 7%
- Other Europe: 5%
- Other: 1%
The titanium supply chain

The global economic conditions are improving

- Strongly agree: 10%
- Agree: 46%
- Neutral: 31%
- Disagree: 13%
- Strongly Disagree: 0%
There is an over-supply of titanium

- Strongly agree: 9%
- Agree: 34%
- Neutral: 14%
- Disagree: 40%
- Strongly Disagree: 3%

The global titanium supply chain currently meets the needs for future demand (0-5 yrs)

- Strongly agree: 6%
- Agree: 71%
- Neutral: 12%
- Disagree: 12%
- Strongly Disagree: 0%
Supply security is a significant issue for the titanium industry

- Strongly agree: 21%
- Agree: 51%
- Neutral: 18%
- Disagree: 8%
- Strongly Disagree: 3%

There is a lack of visibility throughout the supply chain

- Strongly agree: 12%
- Agree: 38%
- Neutral: 31%
- Disagree: 16%
- Strongly Disagree: 3%
Reduced visibility in the supply chain is causing inefficiencies

- Strongly agree: 7%
- Agree: 45%
- Neutral: 24%
- Disagree: 21%
- Strongly Disagree: 3%
The supply of titanium minerals is becoming more uncertain

- Strongly agree: 3%
- Agree: 26%
- Neutral: 42%
- Disagree: 26%
- Strongly Disagree: 3%
Largest sponge producers in 2013

© TZMI: NOT FOR REPRODUCTION
Commercial aerospace is the industry demand driver over the next decade

- Strongly agree: 51%
- Agree: 49%
- Neutral
- Disagree
- Strongly Disagree

Airframes

<table>
<thead>
<tr>
<th>Number of Airframes</th>
<th>2014</th>
<th>2015</th>
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<tbody>
<tr>
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<tr>
<td>Flat</td>
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<td>7%</td>
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Increasing turbine engine temperatures are a threat to future titanium.

<table>
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<tr>
<th>Opinion</th>
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<tr>
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<tr>
<td>Agree</td>
<td>62%</td>
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<tr>
<td>Neutral</td>
<td>24%</td>
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<td>Disagree</td>
<td>15%</td>
</tr>
<tr>
<td>Strongly Disagree</td>
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Jet engines

<table>
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<th>Range</th>
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<tr>
<td>12-15</td>
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<td></td>
<td>10%</td>
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Buy-to-fly ratios for aero-titanium will decrease significantly over the next decade

- Strongly agree: 17%
- Agree: 42%
- Neutral: 22%
- Disagree: 14%
- Strongly Disagree: 6%
Military spending in 2013

2013 real US$ billions

- **US**
- **China**
- **Russia**
- **Saudi Arabia**
- **France**
- **UK**
<table>
<thead>
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<th>Range</th>
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<th>2015</th>
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<td>-8-10</td>
<td>3%</td>
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Oil & Gas

Yearly Breakdown:
- 12-15: 7% (2014), 7% (2015)
- 10-12: 7% (2014), 7% (2015)
- 8-10: 3% (2014), 3% (2015)
- 7-8: 8% (2014), 24% (2015)
- 3-4: 21% (2014), 28% (2015)
- Flat: 14% (2014), 12% (2015)
- -1-2: 3% (2014), 4% (2015)
Desalination

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<thead>
<tr>
<th>Range</th>
<th>2014</th>
<th>2015</th>
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<tbody>
<tr>
<td>10-12</td>
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<tr>
<td>-8-10</td>
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Scrap markets are still the best leading indicator

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<th>Response</th>
<th>Percentage</th>
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<tr>
<td>Strongly agree</td>
<td>8%</td>
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<tr>
<td>Agree</td>
<td>45%</td>
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<tr>
<td>Neutral</td>
<td>34%</td>
</tr>
<tr>
<td>Disagree</td>
<td>13%</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>0%</td>
</tr>
</tbody>
</table>
Innovation
There is sufficient R&D focus on titanium

- Strongly agree: 0%
- Agree: 30%
- Neutral: 27%
- Disagree: 39%
- Strongly Disagree: 3%

R&D programs are leading to improved products that are being commercialized

- Strongly agree: 3%
- Agree: 53%
- Neutral: 31%
- Disagree: 9%
- Strongly Disagree: 3%
Take home points to consider

Vertical integration is good for the global titanium industry

- Strongly agree: 13%
- Agree: 68%
- Neutral: 16%
- Disagree: 0%
- Strongly Disagree: 3%
Titanium manufacturing costs will reduce significantly in the next 10 years

- Strongly agree: 0%
- Agree: 35%
- Neutral: 26%
- Disagree: 35%
- Strongly Disagree: 3%

Emerging suppliers will gain significant market share in the next 10 years

- Strongly agree: 10%
- Agree: 42%
- Neutral: 19%
- Disagree: 29%
- Strongly Disagree: 0%
The total lifecycle cost advantage of titanium is not widely understood

- Strongly agree: 6%
- Agree: 87%
- Neutral: 3%
- Disagree: 3%
- Strongly Disagree: 0%

The titanium industry does a good job at promoting the use of the metal

- Strongly agree: 3%
- Agree: 31%
- Neutral: 34%
- Disagree: 22%
- Strongly Disagree: 9%
How will the next generation utilize titanium?
Thank you