Master Alloys - Often Overlooked but Critical Raw Materials
Forward-looking Information

Statements in this presentation may contain information regarding future events that may be considered "forward-looking statements." Forward-looking statements are subject to various factors and uncertainties that may cause actual results to differ significantly from expectations. These factors and uncertainties include our ability to consummate and successfully integrate future acquisitions; risks associated with international sales and operations; our ability to successfully develop new products, open new facilities or transfer product lines; the price and availability of raw materials; compliance with government regulations, including environmental regulations; changes in the competitive environment or the effects of competition in our markets; the ability to maintain adequate liquidity and financing sources; and general economic conditions affecting the industries we serve. A detailed discussion of these and other factors that may affect our future results is contained in AMETEK’s filings with the U.S. Securities and Exchange Commission, including its most recent reports on Form 10-K, 10-Q and 8-K. AMETEK disclaims any intention or obligation to update or revise any forward-looking statements.
Where are Master Alloys used?

- Master Alloy
- Ti Sponge
- Ti Scrap
- Briquettes
- Electrode
- Cold Hearth
- VAR

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The Titanium Master Alloy World

Vanadium Master Alloys

- Approximately 80% by weight of all Master Alloys
- Al/V chemistries include
  - 65V/35Al
  - 75V/25Al
  - 85V/15Al
- Applications
  - Airframes
  - Engines – rotating parts
  - Industrial
  - Consumer
  - Medical
The Titanium Master Alloy World

Molybdenum Master Alloys

- The next largest master alloy by volume
- Approximately 10% of the MA Market
- Products include
  - 35Al/65Mo
  - AlMoTi
  - MoTi
- Applications
  - Primarily used in jet engine applications
  - Also increasingly used in medical applications
The Titanium Master Alloy World

Niobium Master Alloys

- Nb alloys represent about 5% of the MA market
- Primarily 40Al/60Nb
- Applications
  - Primarily medical applications (Ti 6Al-7Nb)
  - Aerospace (Ti Aluminides)
The Titanium Master Alloy World

Other Master Alloys

- These make up the balance
- Includes multi-component products
  - Ti-17
  - NbAlSiTi
- Other binary alloys
  - AlCr
  - AlSi
- Used in a wide variety of applications
Key Master Alloy Raw Materials

**Aluminum Powder**

- Used in metallic pigments, chemicals, rocket propellants
- Price driven by metal exchanges (LME, COMEX, etc)
- Used as
  - fuel for Master Alloy aluminothermic reaction
  - Master Alloy composition

\[
\text{Metal Oxide} + \text{Al} \rightarrow \text{Master Alloy} + \text{Al}_2\text{O}_3 + \text{heat}
\]
Key Master Alloy Raw Materials

- Demand for both is highly dependent on the global steel industry
- Oxide prices currently part of the global commodity pricing rout with both trading at almost historic lows
- Other key raw materials
  - Nb₂O₅
  - Cr Oxide
  - Sn Oxide
Vanadium

Consumption of Vanadium

Vanadium pricing primarily driven by steel demand
Vanadium Production by Raw Material Type
2015

V205 Suppliers to the Titanium Industry

- Total 81,500 MTV
  - Coproduct Steel Slag: 71%
  - Primary V Ore: 12%
  - Secondary: 17%

Source: TTP Squared
An Industry in Turmoil

- World Steel Capacity Utilization averaged about 70% in 2015
- Dipped to 65% in December 2015
- Some vanadium producers in South Africa are in business rescue.
- Current Index V205 pricing is below the production costs of most major vanadium producers.
Global Vanadium Production

Source: TTP Squared
Recent Vanadium Production

![Bar chart showing recent vanadium production](chart.png)

- Brazil
- Australia
- India
- Taiwan
- Korea
- Japan
- Europe
- North America
- South Africa
- Russia
- China

<table>
<thead>
<tr>
<th>Year</th>
<th>MTV</th>
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<tbody>
<tr>
<td>2014</td>
<td></td>
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<tr>
<td>2015</td>
<td></td>
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<tr>
<td>2016E</td>
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Vanadium Production - A Closer Look

- Only controlled, high purity V₂O₅ can be used to produce master alloys

- World vanadium production is expected to decrease by 15% in 2016 from the peak in 2014

- Aerospace grade vanadium production is either off line or reduced in major producing countries.

- Brazil is the only country with significant expected production increases
  - Not yet aerospace qualified

<table>
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<tr>
<th>Region</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
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<tr>
<td>China</td>
<td>53,170</td>
<td>46,554</td>
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<td>Brazil</td>
<td>500</td>
<td>4,000</td>
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<tr>
<td>World Total</td>
<td>91,605</td>
<td>81,518</td>
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World Vanadium Consumption

97,000 MTV Total

84,000 MTV Total

84,000 MTV Total

MTV

2014 2015 2016E

Other
India
CIS
China
Japan
North America
Europe
Vanadium Production and Consumption
2004-2016

Source: TTP Squared
Vanadium in 2016

- With significant capacity out of the system, vanadium excess inventories should be consumed
- V205 prices expected to remain depressed until there is balance
- Capacity of high purity V₂0₅ currently available for aerospace use will be reduced
Molybdenum Demand by Application

- Engineering steel: 43%
- Stainless Steel: 21%
- Chemicals: 13%
- Foundries: 8%
- Tool Steels: 7%
- Mo Metal: 5%
- Nickel Alloys: 2%
- Titanium Alloys: 1%
Molybdenum World Production and Consumption

![Graph showing Molybdenum Production and Consumption from 2012 to 2016. The graph illustrates the production and consumption trends with the following data points:

- **Production**
  - 2012: 510 M lbs
  - 2013: 550 M lbs
  - 2014: 590 M lbs
  - 2015: 510 M lbs
  - 2016 Est.: 530 M lbs

- **Consumption**
  - 2012: 470 M lbs
  - 2013: 490 M lbs
  - 2014: 530 M lbs
  - 2015: 490 M lbs
  - 2016 Est.: 450 M lbs

Source: IMOA, CRU, Internal Estimates]
Molybdenum in 2016
A Break in the Storm?

- Mo demand is heavily dependent upon steel production
- 75-85% of Mo produced goes into steel
- Mo is not immune from the global commodity market turmoil
- Significant Mo mining capacity is closed or on care and maintenance
- Prices need to improve to bring capacity back on line
The Titanium Scrap and Sponge Relationship

- There is a constant effort by melters to maximize the economics of their raw material input
- Advances in melting technology have enhanced their ability to remelt greater quantities of Ti scrap
- Relative price differentials between titanium scrap and titanium sponge contribute to the selection of charge materials. This has a consequential effect in the demand for Master Alloys
The Balancing Act

When titanium scrap prices are low, more scrap is included in the melt mix.

When titanium sponge prices are low, more sponge and master alloy is consumed in the melt mix.
Titanium Scrap vs. Sponge
relative price dynamic

Titanium Sponge
Ti 6-4 Bulk Weldable

Source: Metalprices.com, Reading Alloys Internal
Master Alloy Consumption

Source: Ametek Reading Alloys Internal Estimates
Forecast for Master Alloy Demand

2010 = 100%

2016-2020 CAGR = 6%

Source: Ametek Reading Alloys Internal Estimates
Key Issues for Master Alloy Producers

- Quality is non-negotiable
- Certification and approval of raw material suppliers.
- Documentation of procedures
- Supplier understanding and acknowledgement of the risk of HDI’s (High Density Inclusions). Tungsten and Tungsten Carbide most frequent.
- Risk prevention strategies
- Inspection
- Record retention
- Audit schedules
Diversified Supplier Base

- World commodity situation has reduced the number of suppliers for various commodities
- Especially true with Vanadium and Molybdenum
- MA producers must continually be on the lookout for new high quality suppliers
- A narrow supply chain is increasingly risky for Master Alloy producers in the current environment
Accurate and Reliable Forecasting

- Global logistics make it challenging to respond to demand spikes

- Raw material lead times are typically 6 weeks or longer

- Some producers are sold out well in advance with long term supply agreements

- Inventory pressures apply to master alloy producers as well
Strengthen the Partnership

• Master Alloy producers are more than just suppliers – they are partners
• There is a tremendous amount of collaboration necessary to ensure material is available for anticipated increases in Master Alloy demand
• Master Alloy producers have the same stakes in the current environment as the rest of the aerospace supply chain
• Master Alloy producers are operating under the same financial constraints as the rest of the supply chain
  – Pressure to reduce costs
  – Pricing pressures
  – Inventory reduction
Going Forward Together

With limited capacity for aerospace quality material, it is important that titanium melters continually strengthen their strategic partnerships with Master Alloy suppliers in order to maintain the health of this critical part of the supply chain.
Thank You!