What is Niobium

• Niobium (Nb) is a grey, rare and soft transition metal with a white lustre.

• Nb is most commonly found in the minerals pyrochlore and columbite, which also contains tantalum in various proportions.

• More than 90% of Nb is transformed in standard grade Ferro-Niobium (FeNb) by adding iron and aluminum. FeNb contains ~66% Nb.

• FeNb is an alloying agent, mainly used in the production of High-Strength Low-Alloy Steels (HSLA):
  • Vehicles, Structural, Pipelines, Bridges, Long Products

• Using Niobium to enhance steel has many benefits:
  • Adds strength, Lightens weight, Improves flexibility/weldability, Increases durability, Reduces costs
Niobium a Critical & Strategic Metal

For several countries, Niobium is a **strategic** metal because it is essential for high-performance applications. It is also a **critical** metal because it is at supply risk owing to the oligopoly nature of the Nb market.

- **USA**
  - National Defense Stockpile (NDS).
- **EU**
  - Report on Critical raw materials for the EU.
    - Nb part of 20 critical materials.
    - Nb demand growth to 2020 identified at >8%/year.
- **Republic of Korea**
  - KORES Stockpile of 60 days of supply or 360t of FeNb (worth ~$9.5M).
- **Japan & China**
  - Known warehouses to hold several tonnes.
Niobium Products & Uses

High strength steels accounts for about 90% of global niobium consumption.

Source: Roskill, Camet Metallurgy

1: Vacuum Grade
Pure Niobium Oxide Demand Drivers

Nb is used in nickel-, cobalt-, and iron-based superalloys for applications such as jet engine components, gas turbines and heat resisting equipment. Nb is also used for superconducting magnets found in magnetic resonance imaging as well as in nuclear particle accelerators.

R&D in high-tech industries = Increase in niobium consumption
Niobium demand growth is mainly driven by two factors: i. Increase in global steel output and ii. Increase in the amount of niobium used in steel. Growth in each major niobium consuming segment obviously contribute to overall niobium demand.

Increase in global steel output
+ Increase in steel quality

= Increase in niobium consumption
Top Steelmakers/Biggest End-Users

High-strength steels are manufactured by large steelmakers and therefore constitute major FeNb customers.

<table>
<thead>
<tr>
<th>Company</th>
<th>Headquarters</th>
<th>Tonnage¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcelorMittal</td>
<td>Luxembourg</td>
<td>96.1</td>
</tr>
<tr>
<td><strong>Nippon Steel &amp; Sumitomo Metal Corp.²</strong></td>
<td>Japan</td>
<td>50.1</td>
</tr>
<tr>
<td>Hebei Steel Group</td>
<td>China</td>
<td>45.8</td>
</tr>
<tr>
<td><strong>Baosteel Group²</strong></td>
<td>China</td>
<td>43.9</td>
</tr>
<tr>
<td>Wuhan Steel Group</td>
<td>China</td>
<td>39.3</td>
</tr>
<tr>
<td><strong>POSCO²</strong></td>
<td>South Korea</td>
<td>38.4</td>
</tr>
<tr>
<td>Shagang Group</td>
<td>China</td>
<td>35.1</td>
</tr>
<tr>
<td>Ansteel Group</td>
<td>China</td>
<td>33.7</td>
</tr>
<tr>
<td><strong>Shougang Group²</strong></td>
<td>China</td>
<td>31.5</td>
</tr>
<tr>
<td><strong>JFE²</strong></td>
<td>Japan</td>
<td>31.2</td>
</tr>
<tr>
<td>Tata Steel Group</td>
<td>India</td>
<td>25.3</td>
</tr>
<tr>
<td>Shandong Steel Group</td>
<td>China</td>
<td>22.8</td>
</tr>
<tr>
<td>U. S. Steel Corporation</td>
<td>USA</td>
<td>20.4</td>
</tr>
<tr>
<td>Nucor Corporation</td>
<td>USA</td>
<td>20.2</td>
</tr>
<tr>
<td>Tianjin Bohai Steel</td>
<td>China</td>
<td>19.3</td>
</tr>
<tr>
<td>Gerdau</td>
<td>Brazil</td>
<td>19.0</td>
</tr>
<tr>
<td>Maanshan Steel</td>
<td>China</td>
<td>18.8</td>
</tr>
<tr>
<td>Hyundai Steel</td>
<td>South Korea</td>
<td>17.2</td>
</tr>
<tr>
<td>Benxi Steel</td>
<td>China</td>
<td>16.8</td>
</tr>
<tr>
<td>Evraz Group</td>
<td>Russia</td>
<td>16.1</td>
</tr>
<tr>
<td>ThyssenKrupp</td>
<td>Germany</td>
<td>15.9</td>
</tr>
<tr>
<td>Severstal</td>
<td>Russia</td>
<td>15.7</td>
</tr>
<tr>
<td>NLMK</td>
<td>Russia</td>
<td>15.5</td>
</tr>
<tr>
<td>Valin Group</td>
<td>China</td>
<td>15.0</td>
</tr>
</tbody>
</table>

Source: Worldsteel Association  
¹: Million tonnes crude steel production 2013  
²: Bought stake in CBMM in 2011
FeNb Apparent Consumption

FeNb demand growth picked up in 2014, with over 7\% year-on-year growth. The demand almost reached the 2007 historic high of 84,000 t. Over the last 10 years it has grown on average by 6.2\% per annum whereas steel output has grown on average by 4.7\%.

Source: Worldsteel Association, Camet Metallurgy
Global Picture

2014 FeNb Consumption shares

2014 Crude steel output shares

Source: Camet Metallurgy
FeNb Intensity of Usage

The disparity in niobium usage between China and the Americas is well displayed here. Overall, Europe, USA and developing countries, in particular India, are offsetting China’s lower consumption.

Source: Cameg Metallurgy
FeNb Pricing

The Ferro-Niobium market is an oligopoly controlled by the only three producing firms. The leader has about 85% of the market shares and sets the prices.

- Prices are essentially determined by the market leader rather than purely driven by supply and demand.
- FeNb is sold directly to steelmakers, generally under one year term contracts. Prices are fixed for the year, bi-yearly or on a quarterly basis.
- There is a very small secondary market where trading firms usually sell on spot basis and where prices can increase up to 20% on smaller quantities.
- Quoted prices by major indexes are often based on trading transactions.
- FeNb is sold in USD, EURO and JPY and on the Nb content, on a delivered basis.
- USA imposes a 5% import duty on Brazilian FeNb.
Overall, FeNb price were very stable over the last five years. If converted in local market currencies, the average price would be over the $40/kg mark. Market trends and sources indicate that price is heading north in medium term. However, steel profitability and niobium usage, in China, still need to improve to allow price increases.

Source: MDIC, Camet Metallurgy
Producer Trio

There are currently only three significant producers of Ferro-Niobium: the Brazilian companies CBMM and Anglo American, and Niobec in Canada. Artisanal small scale mining is also taking place, notably in Africa, but represent only about 1% of total output.

<table>
<thead>
<tr>
<th>Company</th>
<th>Resources</th>
<th>Capacity 2015</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBMM</td>
<td>440 M t @ 2.5%-3.0% Nb₂O₅ (weathered ore) +700 M t @ 1.50% Nb₂O₅ (fresh ore)</td>
<td>~ 110,000 tpa FeNb</td>
<td>• Expansion planned for 2017: ~150,000 tpa FeNb.</td>
</tr>
</tbody>
</table>
| Niobec          | 636 Mt¹ @ 0.42% Nb₂O₅ +84 Mt Inferred @ 0.31% Nb₂O₅                        | ~ 8,300 tpa FeNb                          | • Bought by Magris Resources for $500mm.  
• No expansion announced. |
| AngloAmerican   | 31.1 Mt @ 0.97% Nb₂O₅ +53 Mt Inferred @ 1.12% Nb₂O₅ +14.5 Mt Taillings @ 0.69% Nb₂O₅ | ~ 10,000 tpa FeNb                       | • Just finished their expansion.                                                               |

Source: Companies’ websites  
¹: From 2013 NI 43-101 technical report using block caving method
FeNb market has always been in surplus with CBMM’s capacity to supply the entire demand. Worldwide inventory levels are generally fairly low. Camet reviewed its medium term demand growth downward due to China’s lower growth rate.

Source: Camet Metallurgy
Expansions

Brownfield expansions by the Brazilian producers will be more than sufficient to cover the increase in demand. The Catalao expansion was completed by the end of 2014. New projects are welcomed by end-users in order to broaden source of supply.

Source: Camet Metallurgy
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