Titanium metal – what will the next decade bring?

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Presentation outline

• Historical trends
  • Supply and trade
  • Demand for mill products

• Outlook
  • Titanium industry flowchart
  • Mill product forecasts by sector
  • Supply chain outlook & risks

• Conclusions
Historical titanium trends
Titanium sponge: Production now dominated by China, Japan & Russia

- China has been a significant sponge producer for the last decade, driven by industrial markets
- World titanium production estimated at ~190kt in 2018, following recoveries in output from China, Japan & Russia

Titanium sponge production, 1998-2017 (kt Ti)

Source: Roskill
Titanium sponge: Major trade routes are very consolidated

- Sponge trade highlights the small number of regional production hubs for sponge and melted products

Major sponge trade flows:

- Japan → N. America (premium grade)
- Russia → EU 28
- Kazakhstan → China
- Ukraine → China and N. America

Source: Roskill, GTT
Titanium scrap: Use in melted products remains dominated by the USA

- USA consumed around 75% of world scrap suitable for remelting in 2017, scrap now ~80% of US melted feedstock

Source: USGS, Roskill

**USA: consumption of scrap by application, 2000-2017 (kt Ti)**

*Source: USGS, Roskill*
Melted products: USA leads premium-grade market, China leads industrial-grade

- US capacity includes high amount of EBM and PAM, suitable for remelting. Chinese melting capacity mainly via VAR.
- Capacity includes some double- and triple-melting, so actual ‘available’ capacity is much lower.

*Source: Roskill*

**Titanium melted product capacity by technology, 2018 (ktpy)**
Melted products: High degree of integration between melting & mill product manufacture

- Trade shows the flow of feedstock to mill product manufacturers, based primarily in aerospace production hubs

*Titanium melted products trade matrix, 2017 (13.5 kt)*

Major ingot & slab trade flows:

- USA → France
- USA → UK
- Russia → USA

*Source: Roskill, GTT*
Mill products: Strong recovery in production & exports in 2017-18

- Capacity utilisation thought to be around 75-80% in 2018, driven by healthy industrial and aerospace demand

Titanium mill product output, 2017 (%)

Titanium mill product exports, 2009-2017 (t)

Source: Roskill

Source: GTT
Mill products: Chinese demand has pushed industrial Ti use higher

- Industrial Ti use slowed down during high sponge prices in 2008-2012, but Chinese consumption has led to recovery

*Source: Roskill*
Titanium outlook
Titanium flowchart: Supply chain is characterised by high levels of new scrap generation

Source: Roskill
Mill product outlook (1): High order backlogs for civilian aircraft

- Commercial airframers have order backlogs representing around 9 years’ production
- Jet engine deliveries forecast to grow >3%py between 2018-2028, engines in service to grow ~3.8%py (Airline Monitor)
- General aviation affected by 2008 global economic downturn, yet to recover to 2007 peak
- Civilian & parapublic helicopter deliveries affected by low oil & gas prices in 2015-2017, but expected to stabilise

- Airbus backlog through 31 August 2018:
  7,415
  • (2018 net orders: 219)

- Boeing backlog through 31 August 2018:
  5,894
  • (2018 net orders: 581)
Mill product outlook (2): Military demand continues to grow

- More than 5,000 fighter aircraft expected to be delivered between 2018-2028, led by the F-35
- Deliveries of new Russian (Su-50) and Chinese (JF-17, J-20, J-31) fighter jet models also forecast to grow
- Military helicopters now overtaken civilian rotorcraft, deliveries of 7-8,000 projected over next 10 years
Mill product outlook (3): Industrial, medical & consumer uses show promising signs

- Chemicals: higher growth from chlor-alkali markets, partly helped by EU regulations, but competition in food processing
- Power: high demand expected for nuclear steam turbine blades, China’s blue-sky policy to benefit FGD installation
- Medical & consumer: orthopaedics benefitting from longer life expectancies; Asian middle class to drive consumer use

**Industrial uses of titanium, 2018 (~80 kt)**

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<td>Mixed outlook, ammonia heat exchangers offer best prospects</td>
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Source: Roskill
Mill product outlook (4): But AM expected to reduce Ti specific use

- Aerospace estimated to account for 30% of the metal additive manufacturing market, focused on complex parts
- Titanium AM parts in use by Airbus, Boeing, GE, Safran & Rolls-Royce. Norsk Titanium now Boeing qualified producer

*Outlook for titanium use in aerospace, on “business as usual” and “AM-adjusted” basis*
Ti supply outlook: market may need to adjust to AM impact

- New projects include AMIC/Toho sponge JV in Saudi Arabia (online 2018); Perryman US melt expansion (online 2019)
- Small-sized Chinese mothballed Ti sponge plants unlikely to resume production
- Most supply-side developments focused on Ti products for use with AM (Norsk Titanium, ATI, Perryman)
- Impact of AM on upstream supply chain differs depending on outcome:
  - "High AM impact" may see scrap availability for remelting fall as buy-to-fly ratios reduce; greater premium-grade sponge output would be required – **primarily affecting US melters**
  - "Business as usual" could see higher than expected demand for premium-grade melting capacity – **mainly affecting US and Russian melters**

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Ti supply chain risks: national policies could cause interruptions

- **USA/Russia sanctions**: trade on melted and mill products potentially at risk. VSMPO-Avisma and Boeing opened new titanium forging unit in the Urals in September 2018

- **“No deal” Brexit** may impact UK mill product manufacturers and aerospace supply chains

- **US-China trade tariffs** dispute not a high risk for titanium, but may extend to aircraft. Boeing forecasts China to buy US$1.2T worth of aircraft through to 2037

*Courtesy: Wikipedia*
Conclusions

• Titanium mill product demand forecast to grow ~2%py out to 2028, with industrial uses expected to perform strongly

• **Aerospace** demand for Ti expected to be impacted by growth of AM and larger share of models with lower Ti content

• Availability of scrap for remelting projected to decline; more premium-grade sponge may be required

• Premium-grade melted product capacity could require investments under “business as usual” aerospace Ti scenario

• National policies present some risks to the sector – Russian sanctions and “no deal” Brexit main risks to titanium supply chains, US-China tariffs a risk to end-use markets such as aerospace

• Some challenges for the sector, but next decade is projected to see reasonable growth
New Titanium Metal report published in August 2018:

1. Executive Summary
2. Titanium Flowchart
3. Titanium Supply Chain
4. International Trade
5. Prices
6. Outlook
7. Background
8. Country Profiles
9. End-uses
10. Company Profiles

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