Titanium melted products landscape: have we reached “peak sponge”?  

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1. Growth and status of melting: capacity vs. output

2. Trends in melt raw materials: sponge vs. scrap

3. Impact of future trends on melters and raw materials: aerospace vs. industrial

4. Conclusion
Melt capacity & output

“capacity has increased by 100ktpy since 2013 despite output falling by 17kt”
Melting capacity almost 450ktpy in 2016, but output has fallen since 2012 peak to <200kt

- Melting capacity jumped by almost 100ktpy between 2013 and 2016
- China added 70ktpy, Japan 12.5ktpy and Kazakhstan 8ktpy
- The USA added 6ktpy and France 2ktpy but Russia closed 12ktpy
- Output peaked in 2012 at 216.4kt, and was similar in 2013, but fell sharply in 2014 to 189.5kt
- It has since recovered by 10kt
- Capacity growth in China largely on expectation that demand would continue post boom of 2011/2012
- Will sponge closures in China now domino onto melt capacity?

Source: Roskill based on country and company information and estimates

Note: 1 – VSMPO melting capacity changes with market trends, depending on demand
EBM has featured strongly in melt capacity evolution since 2013

- Toho Titanium added 12ktpy EBM facility in Japan in 2013
- POSUK (POSCO/UKTMP) added 6ktpy EBM in Kazakhstan in 2013 for ingot and slab production (exported to POSCO in Korea for fabrication)
- RTI opened 6ktpy EBM at Canton, OH, USA for melting scrap
- EcoTitanium (UKTMP and Aubert & Duval) are opening 2ktpy EBM plant in France in late 2016 to process European aerospace scrap
- In China, expansion has largely been through large VAR start-ups:
  - Yunnan Titanium added 10ktpy VAR in Kunming, Yunnan
  - Jiangsu Tiangong added 10ktpy VAR in Danyang, Jiangsu
  - Qinghai Shaped added 8ktpy EBM in Qinghai
  - Another four companies opened 2-5ktpy of VAR capacity

Source: Company information and trade press
USA and China dominate melt capacity; VAR remains largest melting process

- China and the USA have almost equal melting capacity in 2016, at ~138ktpy
- Russia and Japan the next largest at 60 and 50ktpy respectively
- Other countries (Europe & CIS) are much smaller producers
- VAR capacity is over 320ktpy, China dominates but US also high capacity
- EBM capacity is almost 100ktpy, mainly in USA
- All Ukrainian capacity is EBM
- ISM and PAM capacity is much smaller, PAM mainly used for upgrading
- VSMPO (Russia) largest ISM capacity

Notes: VAR = Vacuum arc re-melting; ISM = Induction skull melting; PAM = Plasma arc melting; EBM = Electron beam melting
Melt raw materials

“scrap prices show little correlation to scrap demand, which is on the increase”
Scrap use has rocketed since 2011 and is now >25% of melt requirements globally

- Scrap is forecast to account for over 25% of melt feedstock in 2016, up from lows of 5-7% in 2011/12 when sponge in oversupply and a return to 1990/early-2000s average

- Scrap ratio was reduced in mid/late-2000s as China and industrial products had increased significance in melt production

- In the USA, scrap ratio was over 60% in 2014 and 2015, up from 20-30% average in the two decades previously; around 40kt was remelted

Source: Roskill estimates; USGS

Note: 2002 world data excluded due to erroneous sponge and melt supply data, which shows a negative scrap use ratio
With increased integration in the titanium supply chain, more scrap is generated and used internally, rather than entering external supply chains.

Scrap dealers and brokers still have a business, but may increasingly become service companies offering their expertise and services to the integrated producers/consumers.

 Might further titanium value chain integration involve the absorption of independent scrap players?

Source: United Alloys & Metals at Titanium 2015
Trade in waste and scrap has increased in mid-2010s after averaging ~35ktpy since 2007

- Trade in waste and scrap has shown a noticeable up-tick since 2013, and averaged around 55kt in 2015, compared to global supply of 100kt.

- The main trade flows in scrap for remelting (as oppose to FeTi production) are:
  - Canada and UK to the USA
  - USA and UK to Japan

Source: Customs data on GTA; Roskill Pangaea database
Spot scrap pricing at historic lows in 2016, gap between sponge and scrap has increased

- Spot prices of Ti6-4 scrap in the USA collapsed in 2015 according to Platts Metals Week, while Ti6-4 scrap in Europe are also at multi-year lows according to Metal Bulletin.

- Sponge prices are US$2-3/t higher in the 2010s than 1990s on a nominal basis (although US$2-3/t lower after adjusting for inflation).

- The gap between sponge and scrap prices has widened to US$10/kg compared to US$4/kg in the 1990s.

- Low scrap prices indicate oversupply, rather than weak demand.

Source: USGS; Platts Metals Week
New builds of more intensive titanium-using aircraft have boosted scrap supply since 2010

- Titanium consumption in commercial airliners has increased sharply since 2010 as a new generation of aircraft have been launched and deliveries increased
- Buy-weight consumption is now around 30t/aircraft compared to 15t in 2000
- The current spurt in deliveries, and the associated increased demand for titanium fabricated products has boosted scrap supply
- Titanium and scrap generation precedes airliner delivery, but lead times have shortened

Source: Airline Monitor; Roskill estimates
Future landscape

“industrial market may recover, but lagging steel market and booming aerospace will dictate melting direction”
The titanium market has excess melting capacity, largely stemming from China VAR expansion

- Demand from aerospace market expected to climb to 143kt in 2025, but slower growth expected towards/early 2020s
- Demand from industrial market forecast to show some recovery in late 2010s, but may be lumpy
- Use in “other” markets to grow gradually
- Based on historical trend:
  - Ratio of melt supply:mill demand = 1:1.15
  - Ratio of melt capacity:mill demand = 1:2
- The titanium industry therefore has excess capacity in 2016, largely on 2013-2016 China expansion
- Does China need to shutter melt capacity?

Source: Roskill estimates
With scrap so cheap, why buy sponge? The egg has come before the chicken...

- What if steel industry needs less titanium?
- Should the aerospace/industrial market be more concerned about waste/environment?
- Issues:
  - Not all scrap is suitable for remelting
  - Not all remelted product is qualified for aerospace use
  - Industrial market is weak
  - Remelting eqpt. requires investment
- Should the final consumer take the incentive?

Source: Global Titanium Inc. at Titanium 2015; Roskill estimates
Has the titanium industry finally woken to the issue, and advantages, of scrap and EBM?

- Price of titanium sponge (largely dictated by raw materials and energy)
- Availability and quality of scrap (largely dictated by demand and steel trends)
- Melt capacity trends
- Experience, competence, lead times and cost (largely determined by supplier)
- Product demand: aerospace vs. industrial (largely determined by global macro trends)

The USA leads in scrap use for remelting.

Over 50% of melt product output in the USA in 2015 based on scrap.

Global average = 20%, meaning scrap reuse more limited.

China perhaps <10%.

- Example of closed-loop processing:
  - EcoTitanium (Aubert & Duval, UKTMP and UKAD [Eramet & UKTMP])

- Example of likely in-house synergies:
  - PCC with Timet (31.2ktpy EBM)
  - Alcoa with RTI (6.0ktpy PAM)

Source: EcoTitanium
Conclusion
Has the titanium industry reached “peak sponge”? 

- Almost all growth in capacity outside China since 2013 has been in EBM; with the exception of POSUK this has largely been for scrap remelting.

- China has a high sponge:scrap raw material ratio and high industrial:aerospace market ratio, meaning focus has been on VAR, but this was predicated on industrial market expansion and has been overcooked like sponge... closures due?

- Scrap ratio has recovered since early 2010s, on lower industrial output and higher aerospace demand, but China masks larger ex-China ratio.

- Airliner delivery is expected to increase by a third by 2020, further boosting titanium demand AND titanium scrap production.

- If steel industry Ti use plateaus/slow where will additional scrap go? Unless alternatives emerge, scrap can only replace sponge... might we see China switch to scrap to compete with sponge for industrial use?

- The current melting landscape is too heavily focussed on VAR, growth in cold hearth melting (especially EBM) is likely to be rapid between now and 2025.
Thank you
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