RAW MATERIAL MARKET OVERVIEW

2023 Aviation Week A&D Supply Chain Conference

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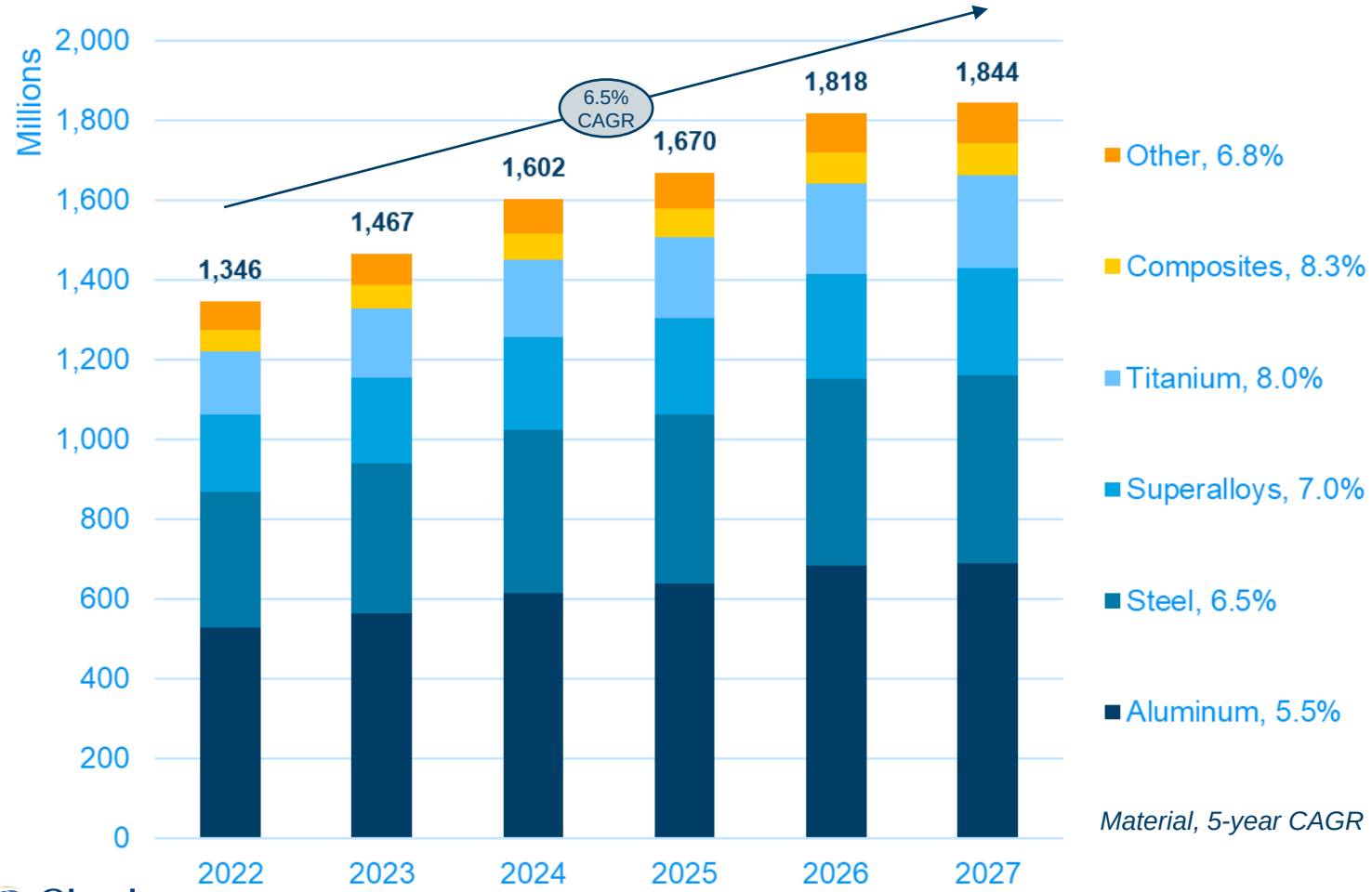
MANAGEMENT CONSULTING

Aerospace raw material demand is expected to increase at 6.5% CAGR from 1.35B lbs in 2022 to 1.84B lbs in 2027

AEROSPACE RAW MATERIALS DEMAND FORECAST BY MATERIAL (M LBS BUY WEIGHT)



Note: Forecast is pre-Boeing 2022 annual report

Source: Charles Edwards

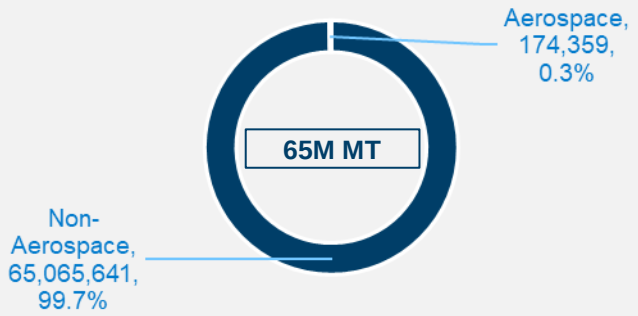
OBSERVATIONS

- Raw material production is offset by roughly one year (e.g., 2022 aircraft production and aftermarket demand drives 2021 raw material production)
- As a result, raw material expected growth rate (CAGR) is lower than that of the aircraft production forecast – it's based on next year's demand
- 2019 / early 2020 overproduction resulted in existing inventory exiting 2020
- Inventory has been drawn down in most segments
- Raw material mill leadtimes are long and/or growing
- Slower recovery of long-haul air traffic favors aluminum and steel over composites and titanium when comparing pre-pandemic to post-pandemic production

Each raw material has distinct drivers and dynamics – here are three

Aluminum

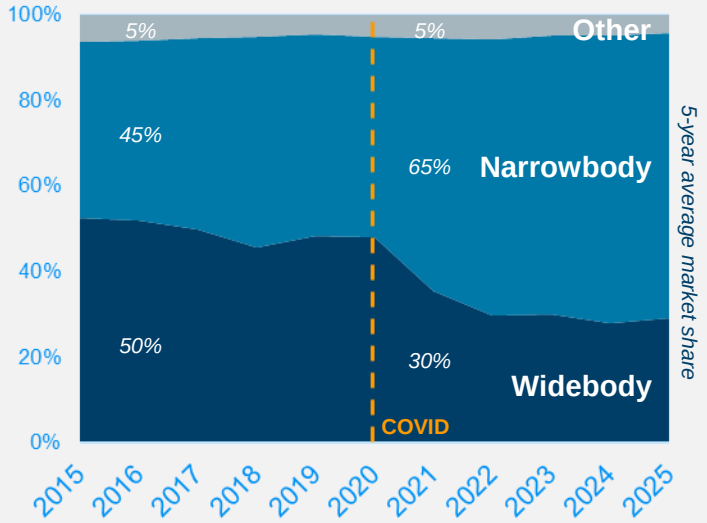
2020 Global Aluminum Production (MT)



- Aluminum is used in many, many products besides aerospace. We estimate that 0.3% of the world's aluminum production goes to aerospace.
- Aluminum's hot sectors are vehicles and packaging.
- Furthermore, aluminum manufacturers believe that they are a declining percentage of future aerospace content by weight.

Composites

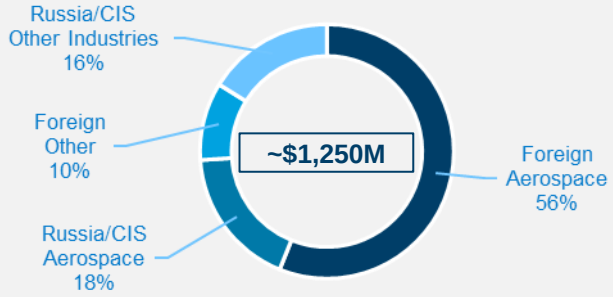
2015-2025 CAT Production Value



- Composites are oil based, used heavily on wide bodies and defense platforms
- Widebodies averaged ~50% of commercial air transport (CAT) production value pre-COVID, but only ~30% post-COVID

Titanium

2021 VSMPO Revenue by End Market

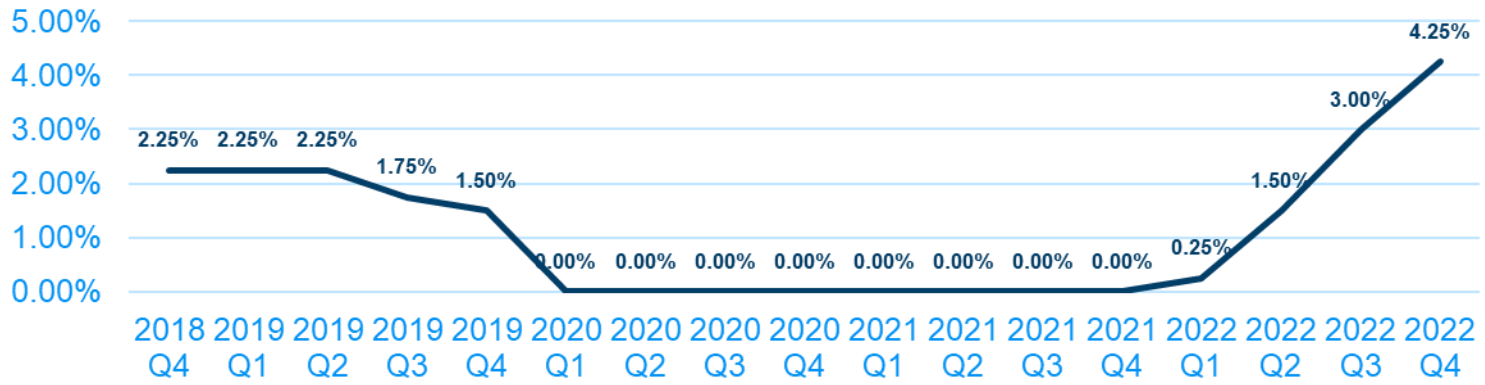


- The geopolitical dynamic is unpredictable to say the least
- VSMPO was approximately 30% of aerospace titanium supply prior to Russia's invasion of Ukraine
- How is VSMPO replaced in the west? What would it take to do it? What happens if we don't?

Source: Charles Edwards analysis

A few poorly performing suppliers could drag the overall production schedule for everyone else

FED FUNDS RATE BY QUARTER (2018-PRESENT)



OBSERVATIONS

- Capital constraints
  - All tiers need to invest for the upturn, which includes working capital
  - However, access to capital is now constrained
  - Rising interest rates mean not only is it harder to get a loan, credit lines are being reduced
  - OEM payment terms remain high (90-120 days)
- Cost Pressures
  - Build rates are down – and costs naturally rise with declining volumes
  - However, pressures to reduce costs have intensified
  - In the meantime, labor costs are rising
  - Material costs have also risen to due input shortages, labor shortages, energy costs, and transportation costs

AEROSPACE SUPPLY CHAIN CHARACTERISTICS BY TIER

Tier	Definition	Customer Payment Terms	Supplier Payment Terms	Capital Market Access	Industries Served
OEM	Final Assembly	Advance	Net 90-120	Good	Aerospace & Defense
One	Large integrator	Net 90-120	Net 90-120	Good	Aerospace & Defense
Two / Three	Fabrication w/ Subassembly	Net 90-120	Net 30	Limited	Aerospace & Defense
Four	Raw Material	Net 30	Net 30?	Good	Multiple

OBSERVATIONS

- OEMs, Tier 1s and 4s begin in a better cash position and have better access to capital
- As the flow of material goes through the supply chain, OEMs, Tier 1s and 4s remain better positioned due to more favorable payment terms
- Tier 2s and 3s will need to make difficult decisions about how firm customer schedules are, how soon to hire and buy material, etc., all of which are risky… while knowing that others in the chain are making the same decisions
- A few poorly performing suppliers could drag the overall production schedule for everyone else

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Source: Charles Edwards, FRED

Two more issues to consider: OEM credibility and raw material usage per aircraft

The OEM's production rates lack credibility with the supply chain

AVIATION WEEK NETWORK

Further Airbus Production Rate Increase 'Very Likely,' Faury Says

Jens Flottau January 10, 2022

> …the supply chains in many cases had their own bets on the market **which were not accurate**, despite the kind of guidance from our side on when we thought the market was going to recover.
>
> *– Boeing VP, Reuters 1/17/23*

Actually, the supplier bets were more accurate than the OEM bets

The industry, in general, has a less experienced workforce operating in a tighter quality environment: MORE SCRAP

AVIATION WEEK NETWORK

Boeing Leans on Quality System To End 787 Crisis

Guy Norris Sean Broderick December 08, 2022

> The company's review of how 787s are built extended into a deep look at its quality management system (QMS) (AW&ST Dec. 6-19, 2021, p. 14). To no one's surprise, the company discovered the need for improvements—**both internally and at many suppliers**
>
> *– Guy Norris & Sean Broderick, AW&ST 2021 Issue*

Inexperienced quality personnel are more likely to call a part scrap than to allow rework and the current quality environment encourages that disposition.

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Source: Charles Edwards, Aviation Week and Space Technology, Reuters

Aerospace Raw Materials Reports
Global Market Outlook and Risk Assessment

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- Reports address all five major raw material families
- Includes supply risk assessments
- Puts aerospace demand and supply in context

Topics

Geopolitical Risk Assessment (including alloying elements)

Demand Segmentations and Analysis

Impact of Ukraine, COVID, Supply Disruption, and Other Key Trends

Demand Forecast

Supply Structure and Supplier Profiles

Scope

- Raw material consumed in new production, maintenance, and major modifications of turbine-powered aircraft
- Civil and military aircraft
- Global
- 5-year forecast (2022–2026)
- Assessment of upstream availability of the major materials and their alloying elements
- Assessment of aerospace mill capacity

Contact me about getting advance copies of our Geopolitical Risk Assessments

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