Aerospace Titanium Demand Outlook

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October 6, 2010
Orlando, FL
TITANIUM 2010 Conference
Baseline Titanium Demand From Aircraft Production

Anticipated Actual Titanium Mill Demand
Titanium Alloys Constitute Approximately 10% Of The Total Material Demand For Aerospace Production

2010 Total Material Demand For Aircraft Production
By Material Type*

- Aluminum is the predominant material consumed in aerospace production – at half of the total consumption
- Titanium alloys are roughly 10% of the total aerospace material demand from production

* Production ONLY, MRO not included
The largest category of titanium alloy is aerostructures—engines and components also consume large quantities.

2010 titanium alloy demand from aircraft and engine production
By system category*

- The majority of titanium alloy is found in aerostructures, used for frames, floor beams, seat tracks, hard attachment points, etc.
- Engines also use large quantities of titanium, commonly in the “cold section” of the engine.
- Components (principally the landing gear) is the third largest titanium alloy category.

98.1M lbs

* Production ONLY, MRO not included

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Source: AeroStrategy analysis
The Air Transport Market Drives Almost Three-Quarters Of Aerospace Titanium Alloy Consumption

2010 Titanium Alloy Demand From Aircraft And Engine Production
By Aircraft Category*

- Air transport leads demand, accounting for almost 70% of consumption
- Military (fixed wing) is the second largest market at 18% of the total
- Rotary wing and business & general aviation are minor markets

* Production ONLY, MRO not included

Source: AeroStrategy analysis
The 777 Platform Leads All Other Programs In Terms Of Total Titanium Alloy Consumed

Top 15 Programs In Terms Of Titanium Alloy Consumption For 2010*

The top 10 programs account for two-thirds of the total titanium alloy consumption

* Production ONLY, MRO not included
Despite The Global Recession, The Air Transport Production Rate Will Likely Remain Steady

AeroStrategy Air Transport Delivery Forecast
(March 2010)

Production rates will be even higher after the recently announced B737 / A320 production rate increases materialize.
As Production Rates On Individual Aircraft Models Increase Several Interesting Dynamics Emerge

### Air Transport Delivery Forecast (March 2010)

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In September 2010, Airbus announced a further increase to 440/year; Boeing responded with B737 rate of 38/mo (not integrated into forecast)

A320 or B737 re-engining in could reduce single aisle deliveries considerably in mid-2010s

A significant B777 refresh could increase deliveries in late 2010s beyond the current baseline

Higher fuel prices could push C-Series production rates well beyond the current forecast of 30/year

USAF tanker decision could change increase and extend B767 production considerably

Projected C919 introduction

Source: AeroStrategy analysis
The Aftermarket Has An Important Impact On Titanium Demand For Gas Turbines...

### Influence Of The Aftermarket

#### Airframe
- Scheduled airframe heavy checks and depot-level maintenance
- Labor-intensive; labor is typically 70% of cost structure
- Major materials consumed: aluminum, composites

**TI Consumption:** LOW

#### Engine
- Major scheduled events (overhaul, hot section inspection)
- Material intensive; parts are 60-70% of cost of engine MRO
- Disks and hubs are life limited and must be destroyed after cycle limits
- Major materials consumed: nickel alloys, titanium, steel

**TI Consumption:** HIGH

#### Components
- Maintenance for aircraft systems and components
- Landing systems
- Avionics
- Auxiliary power unit
- Hydraulics, pneumatics, fuel
- Generally material intensive
- Major materials consumed: aluminum, nickel alloys, steel, titanium, composites

**TI Consumption:** LOW

Source: AeroStrategy analysis; market interviews
Overview Of Life-limited Parts For Gas Turbines

**Disks**

- Life limited parts – must be scrapped and replaced at set interval (e.g., 20K cycles)
- A typical air transport aircraft accrues 2,000 cycles (flights) per year
- On average, disks are replaced every 8-10 years

**Turbine Blades & Vanes**

- Inspected during engine overhauls (generally every 3-5 year)s; engine MRO must make repair/replace decision on each component
- The ratio of replace (scrap) to repair is 1:2 for air transport engines
- On average, turbine blades and vanes are replaced very 8-10 years

A typical air transport engine is overhauled every 4-6 years... Consuming a considerable amount of rotary-grade titanium alloy
This Results In An Additional 15-20% Of Titanium Demand For Rotary Grade Beyond That Of Gas Turbine Production

2010 Titanium Alloy Production And Aftermarket Demand
Total = 106.4 M lbs

- Airframe consumes less than 5% of the total titanium alloy required
- Engines, however, have a large percentage of the titanium demand from the aftermarket (e.g., maintenance, repair and overhaul (MRO)), between 15-20%
- The component aftermarket for titanium is relatively small, at around 5% of total consumption
Titanium Alloy Is Supplied Most Often In Billet Form, Which Accounts For Almost 50% Of All Product Forms

2010 Titanium Alloy Production And Aftermarket Demand
By Material Form

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<thead>
<tr>
<th>Form</th>
<th>Applications</th>
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<tbody>
<tr>
<td>Billet</td>
<td>Forgings for airframe, landing gear, engine disks</td>
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<tr>
<td>Plate</td>
<td>Mainly airframe, pylons</td>
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<tr>
<td>Sheet/strip</td>
<td>Ducting, scuff surfaces</td>
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<td>Bar</td>
<td>Engine blades/vanes</td>
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<tr>
<td>Rod</td>
<td>Fasteners</td>
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<td>Wire</td>
<td>Wing fasteners</td>
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106.4 M lbs
Baseline Titanium Demand From Aircraft Production

Anticipated Actual Titanium Mill Demand
There Are Three Factors That Influence Near-Term Demand For Titanium

Effects of Supply Chain Destocking And Restocking For MRO Demand

#1 DEFERRED MAINTAINANCE & MRO SUPPLY CHAIN DESTOCKING
- To minimize cash flow, firms have chosen to burn down existing stock, particularly affecting engine MRO
- Deferred placement of engine life-limited parts
- Significant cannibalization of new engine parts by used parts

#2 PRODUCTION INVENTORY OVERHANG
- Delays in the 787 (along with the 747-8) have created a significant inventory backlog for airframe titanium

#3 PRODUCTION RATE INCREASES
- Both Boeing and Airbus have announced production rate increase for their narrowbody

Sources: AeroStrategy analysis, interviews
Factor #1: Decreased Demand For Aftermarket Material

AeroStrategy estimates that aftermarket material demand fell 20-30% due to deferred maintenance and destocking in 2009.

- Demand remains soft; low-single digit growth is anticipated in 2010.
- The supply chain will eventually “restock”, thus creating a demand that is in excess of actual production requirements.
Stocking Points Along The Supply Chain Allow For Inventory Build Up, Which Can Attenuate Pull From The Mill…

**Factor #2: Significant Build-Up Of Production Inventory**

**Simplified Aerospace Production Supply Chain**

- Raw Material Mills
- Service Centers & Distributors
- Tier II/III, Casting, & Forging Suppliers
- Tier I Suppliers
- Aircraft & Engine OEMs

**Production Supply Chain Practices**
- Inventory stocking & destocking, use of WIP
- Acts as a buffer between fundamental demand and realized revenue by raw material mills
- Important in times of crisis

**Fundamental Demand For Materials**
- Predicted raw material demand based on aircraft production rates, material content, buy-to-fly ratios
- Adequate to analyze market dynamics when the supply chain is stable

Source: AeroStrategy
... And Much Of The Inventory Is Housed At Boeing-Related Warehouses, Which Reduces Titanium Mill Demand

Factor #2: Production Inventory Build-Up (CONT)

- It is estimated that there is 40 to 50 M lbs of titanium stock, mainly associated with the 787 delay
- This stock is stored at warehouses and includes all mill products, especially ingot and billet
- Due to “take-or-pay” contracts where Boeing is require our customers to take a minimum shipment, burn rate is believed to be slow, lasting 2 to 3 years to return to normal levels
This Decrease Will Be Partially Offset By Increased Narrowbody Production, Which Adds Some 5M Pounds Of Demand

Factor #3: Announced Production Rate Increased

- In September 2010, Airbus announced a further increase of 440/year for the A320 family, effective late 2011/early 2012
- Boeing responded with B737 rate increase to 38/month, corresponding to the same timeline
- These increases, combined with early 2010 adjustments, will increase titanium demand from 15M lbs to 20M lbs for these models
The net result is a mill demand profile that will increase at approximately 14% per annum over the next five years.

2010 To 2015 Anticipated Titanium Aerospace Mill Demand Forecast*
By System Category

* Including affects of inventory burn and MRO destocking/restocking

Source: AeroStrategy analysis
Thank You For Your Attention

- AeroStrategy is a specialist management consulting firm devoted to aviation and aerospace sectors with offices in **Ann Arbor, Michigan, Amersham, U.K., and Singapore**

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