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Titanium in EADS Military Aerospace
Outline

- Overall Titanium Demand
- Airframe Design / A400M
- Helicopters Design / Tiger & NH90
Aerospace Titanium Demand

Worldwide
• Decline in 2010 ~100 kt (destocking)
• Air Transportation ~60% of overall Aerospace
• Military Aerospace ~15 % of overall Aerospace

EADS
• 90 % driven by Airbus programs
• < 10% military aerospace (Transportation, Helicopters, Eurofighter)
• 50% direct EADS demand, 50% from suppliers & subcontractors
Use of Titanium within EADS

• Airframe applications:
  ➢ TA6V ducting, wing structures, attachments, pylon, fasteners, light weight bearings, tubes & pipes, fittings
  ➢ Ti 10.2.3 landing gears

• Limited Aero-engines applications: rotors and mast mainly Ti 10.2.3

• Standardisation policy, no proprietary alloy, diversification of sources
  ➢ Secure supply chain
  ➢ Reduce cost
  ➢ Ease exportation rules compliance
Outline

- Overall Titanium Demand
- Airframe Design / A400M
- Helicopters Design / Tiger & NH90
Airframe material requirements

- An airframe places high demands on its materials often in complex load cases.

**Upper skin:**
- Compression/stability

**Lower skin:**
- Tension/crack growth

- Bending and torsion

- Impact

- Hoop stress and longitudinal stress

- Longitudinal stress
  - Static/residual strength
  - Crack growth

- High local loads / temperature

- Upper skin: Compression/stability

- Lower skin: Tension/crack growth

- Hoop stress, cosmetic

- Bending

- Impact

- Compression due to bending, stability, static strength, corrosion resistance
Titanium use in commercial airframes.

Why is Ti attractive to the airframe industry?

- High strength to weight ratio.
- Inherent resistance to corrosion.
- Compatibility with composites (galvanic and thermal).
- Property stability at elevated temperatures.
- The amount of Titanium employed in an airframe depends on aircraft configuration and design detail.
  ‣ Trade off between design drivers, performance and cost.

- Weight saving.
- Used for highly loaded structure in geometrically constrained areas (LDG, Pylon,..)
- Removes requirement for corrosion coating.
- Simple and robust design.
- Application in medium to high temp areas. E.g APU and pylon structures.
Titanium use in airframes is increasing.....

<table>
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<tr>
<th>Year of Manufacture</th>
<th>Aircraft Type</th>
<th>% Ti</th>
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<tr>
<td>1977</td>
<td>A300 - 310</td>
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<tr>
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<tr>
<td>1993</td>
<td>A330</td>
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<td>A340-500/600</td>
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<td>2013</td>
<td>A350</td>
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Composite and Titanium increasing use over time.

- CFRP structural weight %
- Titanium %

- A300
- A310/200
- A320
- A340-300
- A340-600
- A380
- A400M

- Fairing NL/G Doors
- HTP, MLG Doors
- Moveable VTP
- Keel Beam
- Rear Pressure Bulkhead

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Titanium Applications on A380 structure.

Nacelles:
- skins plug and nose
- attachments
- attachment ring,

Primary structure of pylon

Landing gear: truck beam...

Roller track (flap track)

Spoiler and Aileron fittings

- Attachment between inner flap and wing: Trunion

HTP center joint

Primary structure of pylon

Rear fuselage

Pintle fittings

Thrust Fittings
Military Transportation: A400M

• Ti used in A400M: 7% of airframe weight (excl. Engines & LG)

• Main applications:
  - Pylon Full primary structure
  - Pylon Secondary structure (partially)
  - Nacelles Cowls and firewalls,
  - Landing Gear Parts (trailing arms),
  - Fasteners (Hi-Lite...) ~1/3 of overall Ti weight
  - Door hinges, fittings in hybrid assemblies (CWB, VTP...)
  - Few fuselage doublers, HTP centre joint (tees & fittings), nozzle, exhaust ....
Military Transportation: A400M

- Mainly Ti6-4 (all forms: rolled, forged, die-forged, cast...)

- A few specific hot temperature alloys (exhaust, nozzle)

- Rationale for using Ti:
  - Lightweight alternative to Steel for hot areas and/or highly loaded areas (including fasteners)
  - Replacement of Aluminium 7xxx forms when above capabilities
  - Compatibility with CFRP for hybrid structures (Aluminium/CFRP)
  - Corrosion resistance
Material breakdown

CFRP: Fuselage, wing box, movables,..

Al/Al-Li: Frames, Ribs, Floor beams, Gear bays,..

Ti: Landing Gears, Pylons, Attachments, door surrounding, frames,..

- Composite: 53%
- Titanium: 14%
- Steel: 7%
- Al/Al-Li: 19%
- Misc.: 7%
Limitation of Titanium use.

- Raw material cost (more than twice Aluminium)
- Density
- Buy to fly ratio: Cannot be designed as Aluminium
- Drilling and Machining ability / related cost
- Wearing

> Global cost is now the most important driver
Titanium Use within Helicopters

Titanium benefits:
Weight saving & ratio density
Ductility, stainless / corrosion resistance
Fire resistance -> use in engine area

Titanium drawbacks: Fatigue performances lower than steel
Ti 10.2.3 fatigue resistance ~ to 15-5 PH steel thus 50% better than TA6V
Ti 10.2.3 max static load / density ratio far better than steel

Usage:
Isolated Titanium use in civil helicopters like Super Puma (costly)
Progressively appearing on military applications
Triple melting for rotating parts
Military Helicopter: Tiger
Military Helicopter: Tiger

• Tiger fighter helicopter: composite structure, designed in the 80s
• Limited Ti use ~1 % of total weight
• Mainly TA6V
• Engine support: rods & special washers
• Rotor mast: housing, spacer bearing, friction ring
• Tail rotor: rotor mast
Military Helicopter: NH-90
Military Helicopter: NH-90

• Military transportation helicopter, designed during the 90s
• Joint venture between France, Germany, Italy, and the Netherlands
• Use of Titanium (Ti 10.2.3) instead of steel within rotor/blades structure
  ➢ sleeves
  ➢ main rotor hub
  ➢ tail rotor mast
• Overall Ti use ~5% of total weight
• Significant cost penalty