Advanced Composites – Competitor of Titanium?
Welcome to the Composites Age!

- Why Composites?
- Aerospace Adoption to date
- What’s next?
Composites are combinations of two materials with a distinct interface, the reinforcement (e.g., Carbon Fiber) & the matrix (e.g., epoxy resin).

Composites combine the strength of the reinforcement with the toughness of the matrix. Resulting material properties are anisotropic and cannot be achieved by any of the components acting alone.
Advantages for Aircraft Design

- **Weight Savings**
  - Specific properties offer 30+% 

- **Anisotropy**
  - Ability for optimization 

- **Durability**
  - Greatly improved fatigue and corrosion resistance
Weaknesses of Composites

• Off-axis and point loadings
• Operating temperatures above 300°F
• Conductivity
• Manufacturing infrastructure and cost
Military Aircraft use of Composites

Composites as Enabling Materials
- Lightweight, stiff and strong
- Long life – limited fatigue
- Limited corrosion
- Extended combat radius
- Stealth

Composite Content by Weight
- 5-12%
- 25-30%
- 35-50%
Commercial Aircraft use of Composites

Mike Canario, VP/GM Americas
October 6-9, 2013 • Caesars Palace, Las Vegas, Nevada, USA
Catalyst for Change!
Commercial Aircraft use of Composites

- **Titanium**: 14%
- **Steel**: 7%
- **Al / Al-Li**: 7%
- **Misc.**: 20%
- **Composite**: 52%

### Timeline
- **1980**: A310, B767
- **1985**: A320
- **1990**: B777
- **1995**: A340-500/600
- **2000**: A380
- **2005**: 787, A350
- **2010**: 787/A350
- **2015**: 787/A350

- **787/A350**: 50%+%
- **787**: 23%
- **A350**: 4-6%
- **10-15%**: A340-500/600
A350 Composite Primary Structure
Fuselage Frames and Stringers
Forward & Center Fuselage Sections

Sections 11-12
Manufactured by Aerolia

Sections 13-14
Manufactured by Premium Aerotec

Sections 15 & 21
Manufactured by Spirit, Airbus and EADS
Aft Fuselage Sections

Sections 16-19
Manufactured by Premium Aerotec and Airbus
Vertical Tail & Horizontal Stabilizer

Manufactured by Aernnova & Aciturri
Wing Skins and Spars

Manufactured by Airbus, Spirit & GKN

Upper Skin

Rear Spar

Front Spar

Lower Skin
Metal Components on 787/A350

• Attachment fittings
• Landing Gear
• Engine Struts
• Fasteners
Titanium vs. Aluminum on a Composite Plane

• Galvanic corrosion issue when aluminum and carbon are in contact
  – Requires insulation in assembly AND inspection in service

• Can’t use Aluminum rivets to assemble plane!
What’s Next?

- Composites design and manufacturing to evolve
- Total part costs will come down
- Limitations will still exist
- Significant opportunities for Composites and Titanium!