Engineering Plastics for Aircraft

Reduce Weight, Enhance Reliability, Lower Maintenance Costs

Webinar Presented by Curbell Plastics

CURBELL PLASTICS

Today's Presenter:

Scott Reed, Senior Business Development Manager - Aerospace

With 18 years of plastics experience and a strong technical background in polymers, Scott specializes in helping aerospace manufacturers find the right materials to improve efficiency and safety.

Engineering Plastics for Aircraft

Reduce Weight, Enhance Reliability, Lower Maintenance Costs

Webinar Presented by Curbell Plastics

CURBELL PLASTICS

Poll

Do you know which commercial aircraft has the highest percentage of plastics and composites in its construction?

- Boeing 787 Dreamliner
- Boeing 777
- Airbus A350
- Not sure

Agenda

- The role plastics play today in aerospace
- Why plastics may be a better choice vs metals
- What applications may use plastics
- Factors to consider when choosing plastics
- The growing opportunities for plastics in aviation

Engineering Plastics in Aerospace

According to Grand View Research Online*

- 2011 $6.2B
- 2024 $8.15B = 31% Growth
- Expected to grow through 2030 at 9.3% CAGR Approx. $12.64B

*** Source:** Aerospace Plastics Market Size, Share, Growth Report, 2030

Plastics in Aerospace Introduction

History – One Driver for Plastics was WWII

- One of the first applications were canopies from acrylics which replaced glass
  - Early canopies were double plates of glass held together by a frame
- Japan limiting metal trade
- Need for faster, stronger aircraft
- OPEC oil embargo of 1974 pushed the development of more rubber and plastics

Plastic History

1907	1930's - 1970's	1935	1960's	1978	Late 1970's
One of the first plastics developed was Bakelite thermoset, commercially available in 1938	Additives such as glass, carbon, and graphite were introduced into plastics	Nylon was developed by DuPont™, commercially available in 1938	DuPont™ Vespel®, commercially available in 1965	PEEK, commercially available in 1981	Ultem® was developed, commercially available in 1982

Systems on the Aircraft

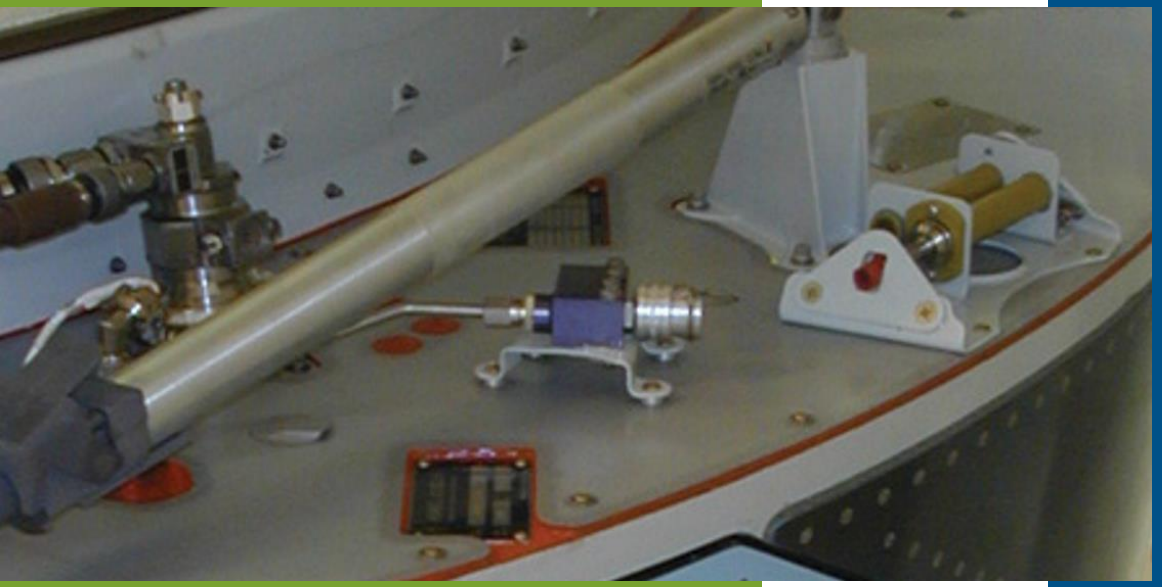
- Fuselage
- Wings
- Nacelles
- Engines
- Landing gear
- Fuel systems
- HVAC
- Electronics
- Interiors

Aircraft Wings

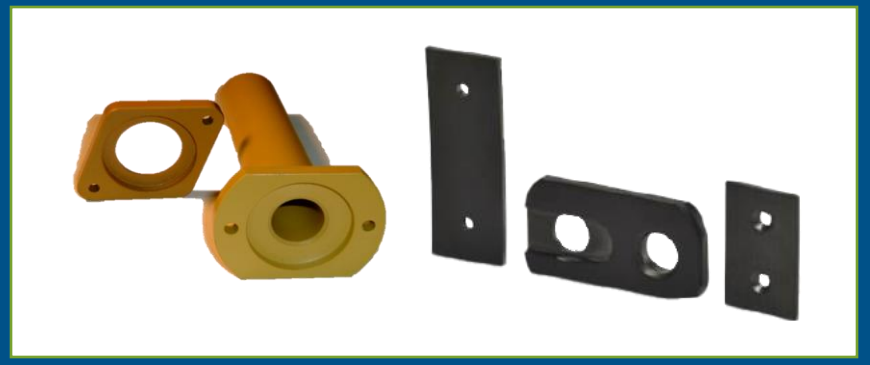
- PTFE and PEEK wire harness wrapping
- PEEK seals
- Torlon® PAI for bearings and bushings often found in moving parts like ailerons and flaps

FACT : The Boeing 787 has approximately 500 km, or 1,640,420 ft, of wiring throughout the aircraft

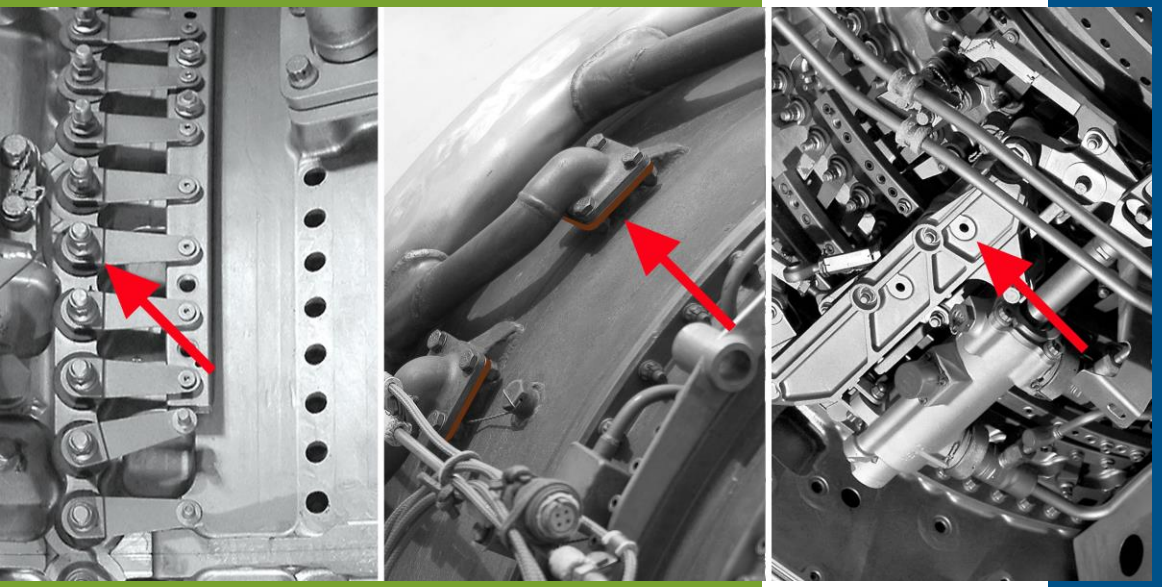
Nacelles



- Shroud (vein stems) on a jet engine compressor are typically aluminum or titanium
- Vespel® Polyimide as composite shroud protects expensive metal vain stems and lowers aircraft weight
- Torlon® PAI is very stable with a low CTE



Engines



Vespel® – fan blade wear strips, spacers, seals

- High service temps to consider
- Dimensional stability
- Mating metal surfaces
- Chemicals
- Wear life

Landing Gear

- High strength to reduce shock loads during landing
- Temperature resistance
- Aviation fuel, hydraulic fluid, de-ice resistance
- PEEK greaser plug
- Nylon as a clamping block

Fuel and Hydraulic Systems

- Torlon® PAI – Boeing approved as an insulator
  - Hydraulic lines to run through fuel tanks
  - Reducing weight
  - Low thermal conductivity specific to 4203
  - Hose ribbing and clamps
- Vespel® – for bearings and bushings
  - Exceptional thermal stability
  - Inherent flame resistance

Fuel and Hydraulic Systems

- PEEK – used in seals, gaskets, valves, and fittings
- PTFE – for seals, gaskets, and bearings for slide plates
- PPS – used in fuel systems as connectors and housings
  - Good chemical resistance to fuels and hydraulics
- Ultem® PEI –used in fuel systems as manifolds and covers, hydraulic line clamps and supports

HVAC Systems

- Vespel® – used in exchangers, condensers and pumps, bleed valve systems, linear guides, and threaded bushings
- PEEK – seals in condensers and pumps
- PTFE – seals
- PPS – housings and coverings
- Acetal (POM) – used for rigid parts
  - Chemical resistance to fuels and fluids
- TECANYL® VH2 PPE – for mounting brackets and spacers

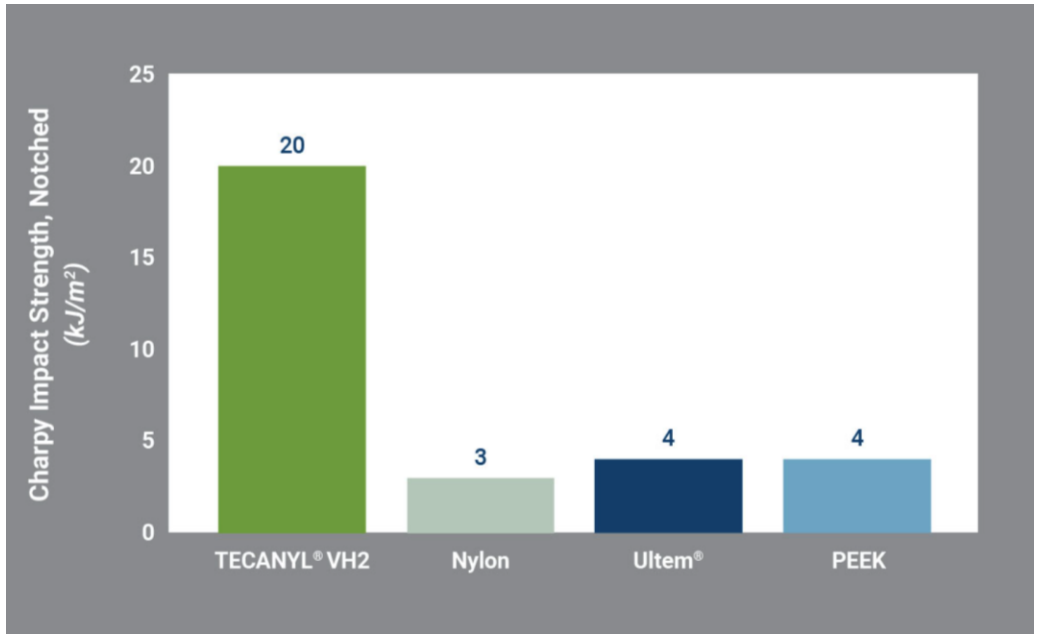
TECANYL® VH2 PPE

Benefits of TECANYL® VH2:

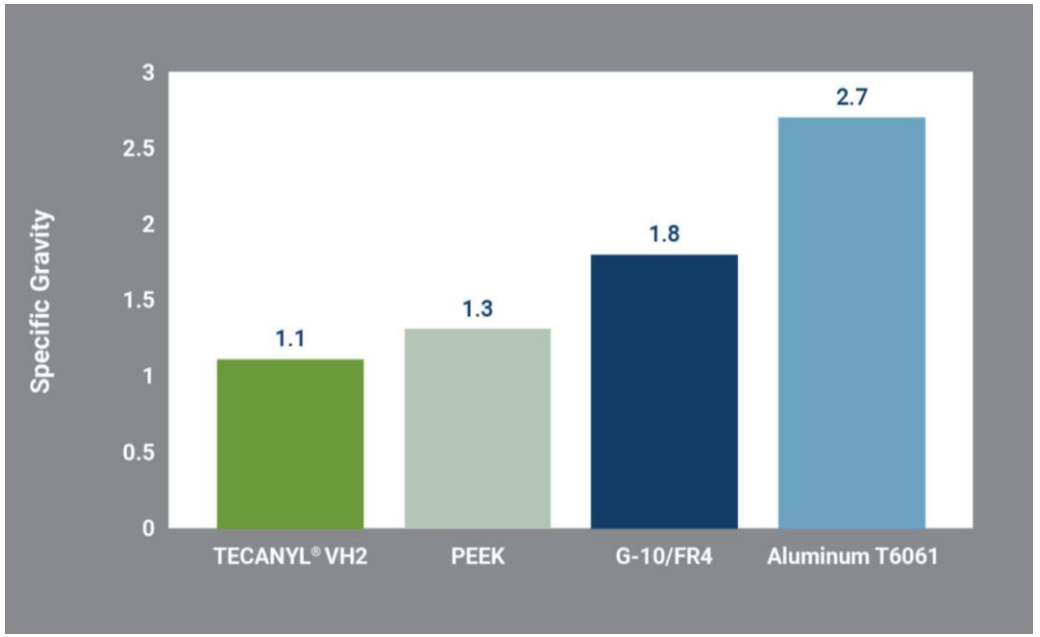
- Dimensional stability
- Toughness and durability
- Excellent flammability characteristics
- Lower cost than some other high performance polymers including PEEK and Torlon® PAI
- Lightweight, less than half the density of aluminum
- Can be recycled

TECANYL® VH2 PPE Comparisons

Charpy Impact Strength (Notched) of TECANYL® and Other Thermoplastics



Specific Gravity of TECANYL® and Other Materials



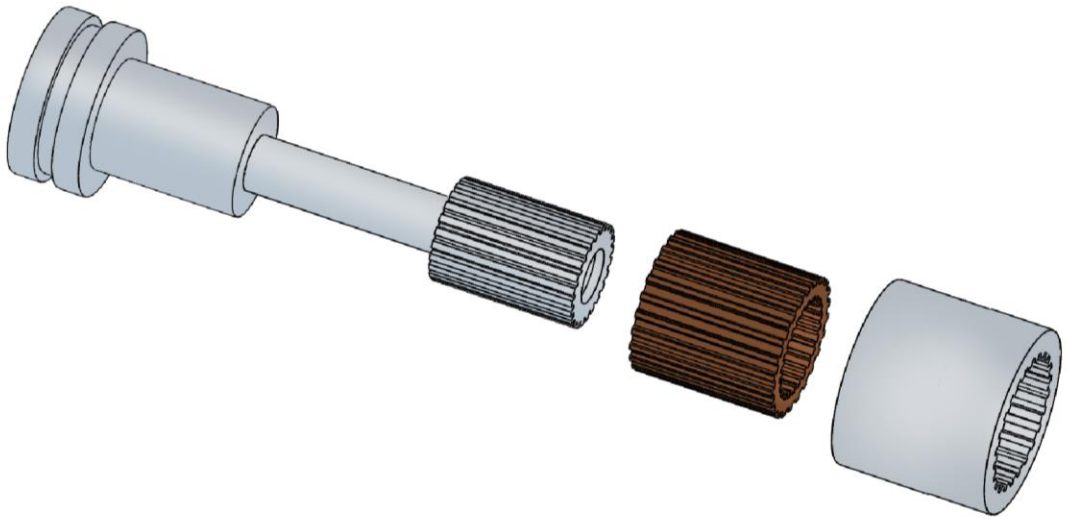
TECANYL® VH2 PPE Product Information: Curbell TECANYL® VH2 Data Sheet, Article: TECANYL® VH2 Aerospace-Grade PPE Thermoplastic

Electronics

Several engineering plastics are used in this area especially for interconnects

- PEEK and glass-filled PEEK
- Ultem®
- Torlon® PAI
- PTFE for pins
- PPS
- TECANYL® VH2 PPE for panels, guides, and brackets

Systems and Gears



Vespel® is often found as a spline adaptor for:

- Reduced wear on metal splines
- Extended service life for spline connections
- Ductile behavior of spline couplings allowing for some degree of shaft misalignment
- Couplings reduce the stresses on bearings when shafts are misaligned
- Spline couplings can eliminate the need for external lubrication in certain applications
- For more information download the *Military and Aerospace Spline Couplings* white paper

Locking Fasteners

Vespel® advantages for locking fasteners:

- Torque retention
- High-temperature operation (up to 450˚F)
- Reduced bolt damage from torque
- Good creep resistance

Market Drivers / Needs

Increased Efficiency

- Weight calculation x fleet x life
  - 1 kg or 2.2 lbs. weight savings = approximately $98.12 per year in fuel savings per aircraft
  - A large commercial fleet of approximately 977 aircraft = $97,825.64 savings in fuel per year
  - 11 years of operation saves approximately $1,076,082.04 over life of fleet

Market Drivers / Needs

- More capacity
- Noise reductions
- Increased life of service
- Materials needed for:
  - High specific strength
  - High specific modulus
  - Self lubricating / low friction and wear
  - Temperature resistance and reliability
  - Fire resistance / non-smoke generating
  - Ease of manufacturing

Critical Elements of Quality

Specifications

- ASTM
- Mil Spec
- FAR Specs – FAR 25.853 a1f1
- Possible exceptions

Critical Elements of Quality

Specifications

- SAE and AMS specs (Society of Automotive Engineers, Aerospace Materials Specifications)
- Resin considerations
  - Pure or compounded
  - PTFE specs
  - IM vs extruded specs

Specification Examples

- PEEK – Polyetheretherketone
- Extruded – ASTM D-6262 S-PAEK **0111**
- Compression Molded – ASTM D 6262 S-PAEK **0211**
- BMS Resin spec BMS 8-317A
- Mil Spec Mil-P-46183
- GF30 – ASTM D-6262 S-PAEK **0122**
- CA 30 – ASTM –D-6262 S-PAEK **0130**

Factors of Consideration

- Service temperature
- Operating temperatures
  - Example: Tarmac to Altitude Temperatures and Time = 110˚F to -40˚F
    - 12-15 min at 2500 fpm
- Chemicals
  - Jet A fuel
  - Skydrol® – hydraulic fluid
  - De-icing – Glycol
  - Cleaning agents

UAV (Unmanned Aerial Vehicle) Market

- Weight is critical
  - Payload can vary cameras to munitions
- Environmental stress
  - Unmanned all environmental challenges exist
- High vibration and fatigue
  - Much higher rpm’s on smaller motors
    - Effects structural fatigue
    - Stability
    - Structural integrity with fasteners

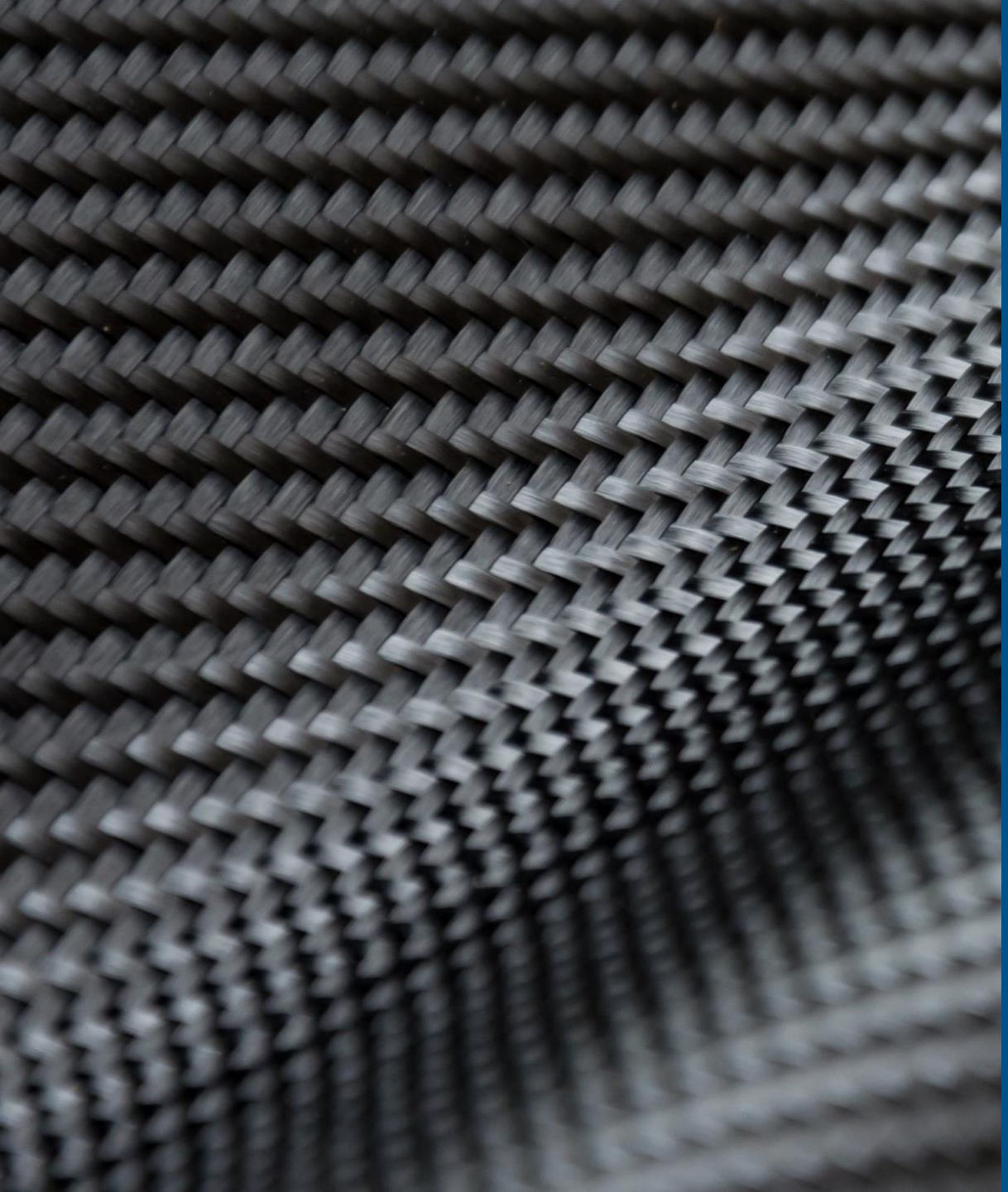
Materials for UAV

- ABS – bodies and casings
- Polycarbonate – extreme impact, optical quality
- Nylon – gears and vibration dampening
- Vespel® – spline adaptors
- PEEK – gears and radomes
- Fluoropolymers – antenna protection and radomes

The Future of Aerospace

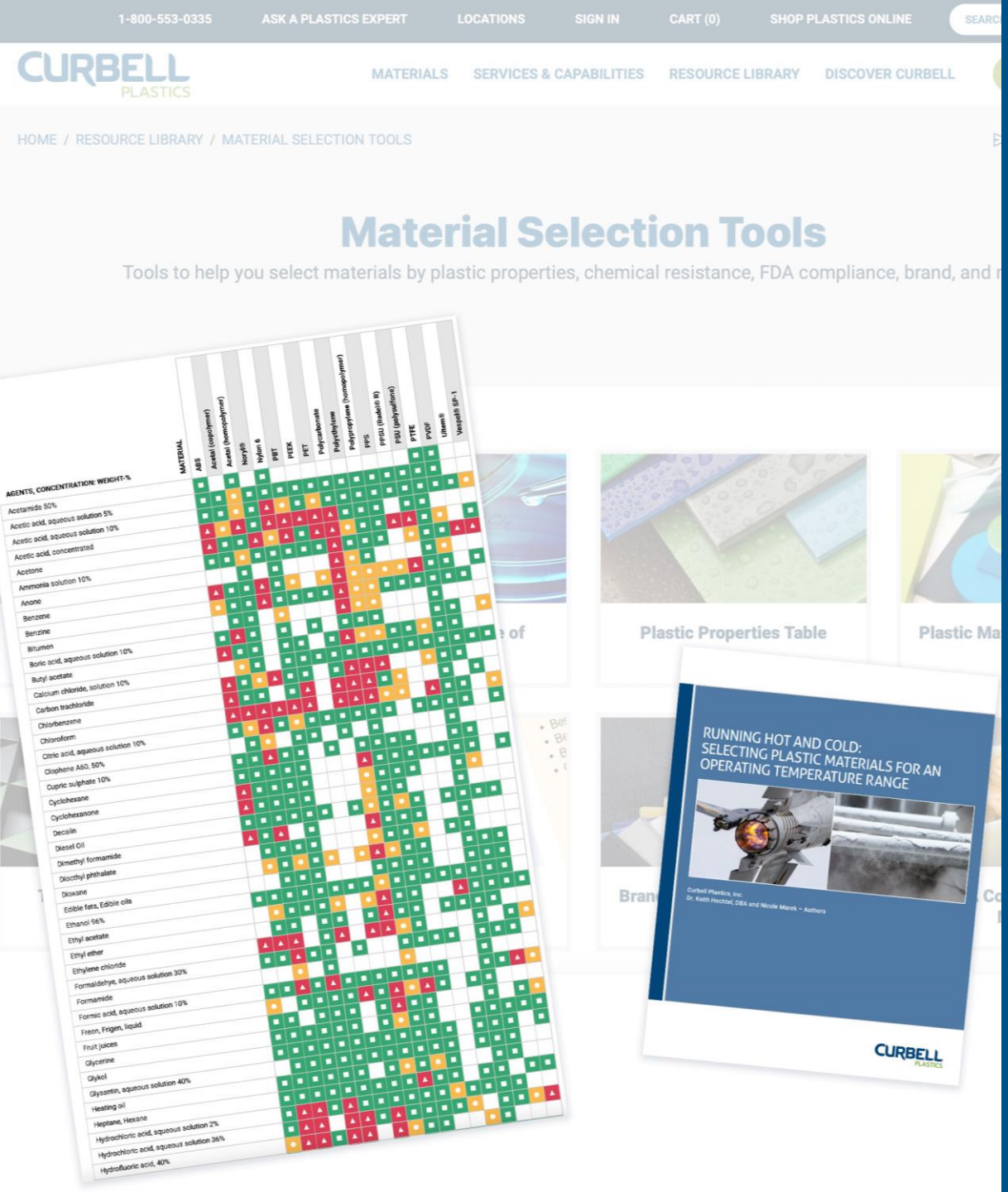
- German Aerospace Center – first thermoplastic fuselage – 1 ton
- Replaced aluminum
- Weight savings
- Reuters Airbus article** – Boeing eyes fast output as plastics loom for future

** **Source:** Exclusive: Airbus, Boeing eye fast output as plastics loom for future jets | Reuters



Thermoplastic Composite

- Repeatable
- Strength to weight
- Pressure form
- Lower cost of production and scrap
- Unique directional fibers specific to applications
- **75%** lighter than steel
- **50%** lighter than aluminum
- **55k + PSI** tensile strength



Available at Curbell

- Material selector guides
- Chemical resistance data
- Plastic properties tables
- White papers
- Plastic comparisons for valves and seals
- Case studies
- Webinars
- Team of material and application experts to support you

Conclusion

- Thermoplastics continue to evolve and play a more critical roll in the construction and integrity of aircraft
- Weight and environmental considerations continue to drive innovation
- The current industry goal is a 10% weight reduction and 20% fuel savings
- With these types of initiatives, it is exciting to think how engineering plastics will be more and more relevant in the future of aviation

Coming in JUNE! – Aircraft Interiors Webinar

Please join me in two months for a webinar covering plastic materials for aircraft interiors

Watch Your Inbox for the Invite

Thank you for your time today!
Questions?

- **Ask a Plastics Expert** form on curbellplastics.com for help with your applications
- Ask about customized presentations
- Curbell Plastics toll free phone: 888-287-2355
- www.curbellplastics.com

Scott Reed
Sr. Business Development Manager - Aerospace
Curbell Plastics, Inc.
office: 817-640-8790 x3253
mobile: 214-422-1847
sreed@curbellplastics.com

CURBELL PLASTICS