



# Zoltek Corporation

How Zoltek's Commercialization Strategy Facilitates Industry Growth



# Brief History of Zoltek



- 1988:** Entered Carbon fiber business via acquisition of specialty CF friction products business. Zoltek has supplied 100% of GE's jet engine inlet hot bearing for 25+ years
- 1992:** IPO, ZOLT on Nasdaq
- 1998:** Launched Low Cost Carbon Fiber Concept

## Locations:

Headquarters:	<i>St. Louis, Missouri</i>
Production Carbon Fiber:	<i>Hungary/USA (Texas)/Mexico</i>
Production Fabric and Prepreg:	<i>Hungary and USA (St. Louis, MO)</i>

## Businesses:

- Manufacturing Oxidized PAN and Carbon Fiber Products
- Composite Equipment (Entec)

## Markets Served:

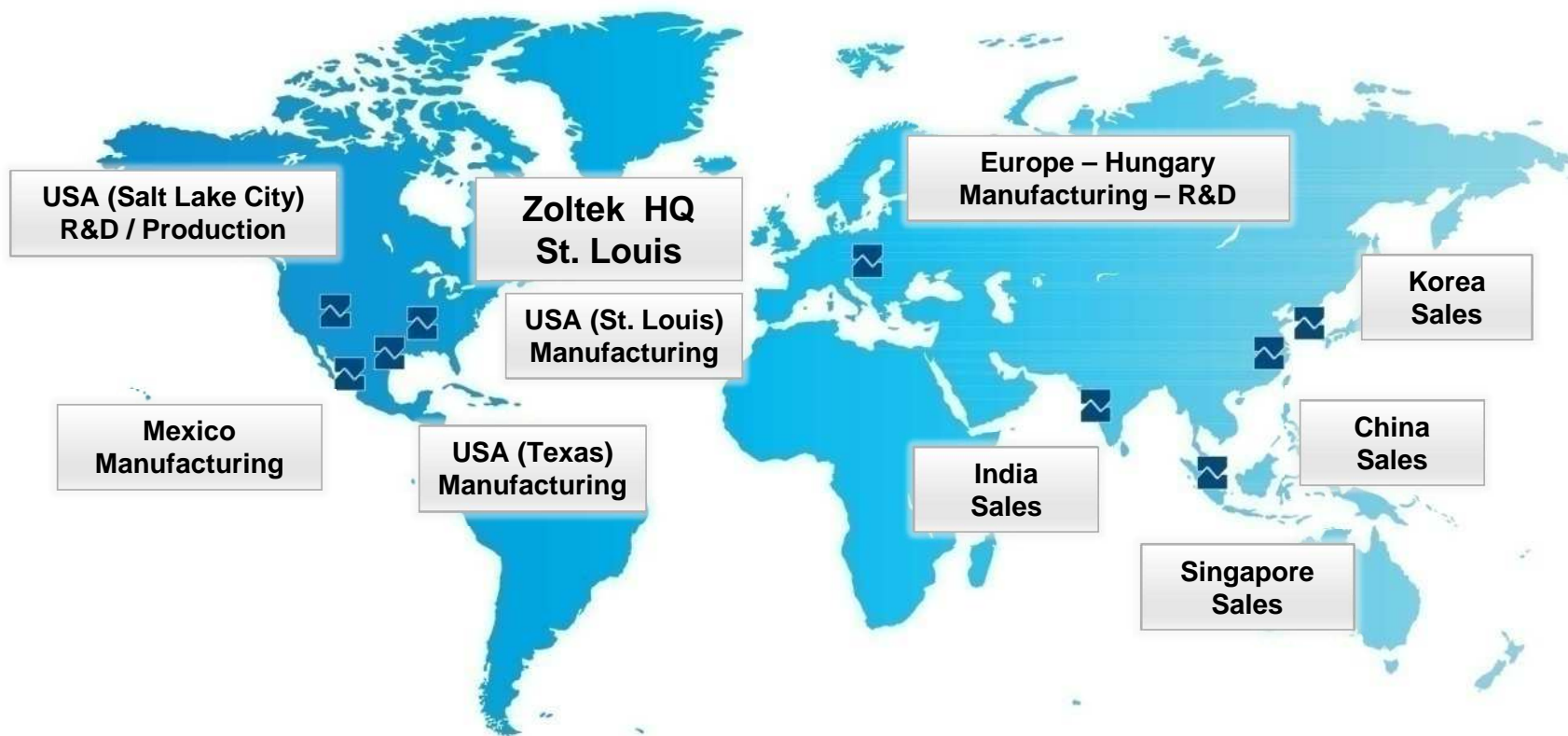
- Carbon Fiber: Wind, Transportation, Oil/Gas, Energy Storage, Infrastructure, TP
- Oxidized PAN: Aircraft Brakes 75+% of CC brakes globally

## Recent Zoltek News



- 27 Mar 2012** – Zoltek and Magna Join Forces to Speed Auto Industry Adoption of Carbon Fiber Material
- 05 Mar 2012** – Zoltek to Showcase Prepreg at JEC in Paris, FR
- 17 Nov 2011** – Zoltek Opening New Prepreg Operations and Tech Center in St. Louis, MO
- 17 Aug 2011** – Zoltek Receives U.S. Department of Energy Award for Low-Cost Carbon Fiber Development
- 14 Apr 2011** – Two More Zoltek Products Receive Germanischer Lloyd Approval

# Zoltek Worldwide



# Our Facilities



## St Louis, MO - Headquarters



## St Louis - MRP & Prepreg Facility

- Applications Development
- Composite Testing
- Technical Fibre Development
- Aircraft Brake Fibres Production
- Molding process Development
- Prepregs & tow process machine supplier
- Composite laboratory (Sizing development)
- Intermediate product Development



## Salt Lake City - Entec Composite Machines

- Composite Machine Manufacturer
  - Filament Winding Machines
  - Pultrusion Machines
  - Fiber Placement Software
  - Composite Technology R&D



# Our Facilities



## Hungary

- Precursor Production 20,000 Metric Ton +
- Carbon Fiber production capacity 8100 MT
- Unidirectional CF Fibre Fabric production
- Applications Development (EU companies)
- Investment over \$100 MM - 120 acre site - Over 1000 employees



## Texas

- Carbon Fiber production capacity 2500 MT .
- Short Fiber (Chopped & Milled) 1350 MT
- Investment over \$45MM - 20 acre site - over 150 employees



## Mexico

- New Facility to supply future demand
- Precursor Production capacity 28,000 MT (capacity over 60,000 MT)
- Investment over \$100 MM - 160 acre site



# Our Mission



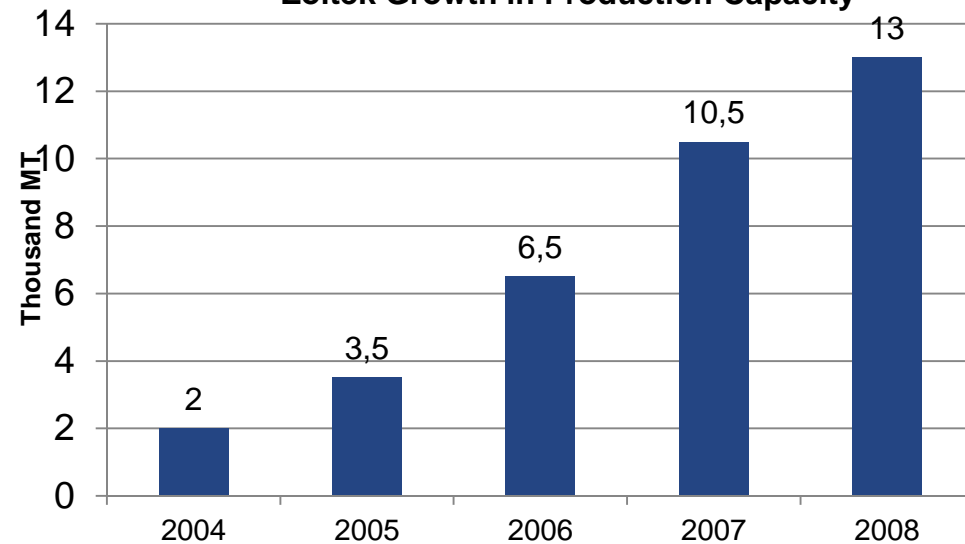
## Lead the Commercialization of Carbon Fiber for Industrial Applications

- Target industrial markets (e.g. wind, automotive)
- Low cost/high throughput production
- Growing capacity with or ahead of market demand. Capable of Capacity Expansion in 6 months.
- Independence from aerospace pricing cycles
- Supply/Pricing commitment via long term contracts

Supply Availability is critical to our customers and our commercialization strategy

Over a 4 year period (2005 – 2008), Zoltek demonstrated the ability to quickly ramp capacity to meet the commercial carbon fiber demands driven by Wind Energy

**Zoltek Growth in Production Capacity**



# Our Markets



- Wind Energy
- Automotive
- High-Performance Braking
- F. W / CNG / Pressure Vessels
- Infrastructure
- Oil and Gas
- Secondary Aircraft Structures
- Marine
- Sporting Goods





# Wind Energy

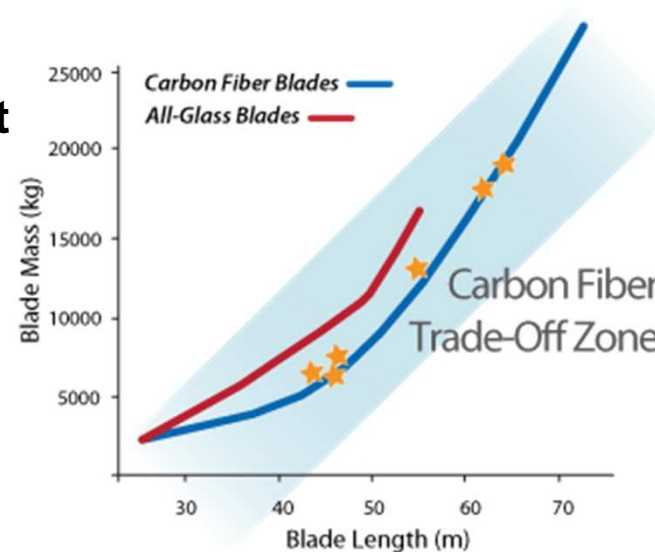


Year by year, wind turbine blades are growing larger and more powerful. Too large, in fact, to support their own weight with traditional materials.

**Carbon fiber is the enabling material that makes wind energy viable.**

Zoltek Wind Energy Products:

- **Continuous Tow**
- **Infusible Fabrics**
- **Prepreg**



**20,000 tons of Zoltek carbon fiber have been installed in wind turbines worldwide.**

# Automotive



Zoltek Automotive was established to develop and assist the expand the use of carbon fiber in the automotive industry.

**Carbon Fiber parts weigh less, improving fuel efficiency and overall vehicle performance.**

Zoltek Automotive Processing Technologies:

- **Resin Transfer Molding**
- **Injection Molding**
- **Compression Molding**
- **Sheet Molding Compounding**



This automotive front end was made with Panex 35 continuous tow via direct injection molding; it was created in less than 60 seconds and weighs less than 10 lbs.

# High-Performance Braking



Zoltek's carbon braking materials are manufactured to withstand extreme braking conditions that demand resistance to harsh temperatures and chemical environments.

Benefits of Carbon Braking:

- **Superior Stopping Power**
- **Overall Mass Reduction**
- **Longer Lasting Brakes**
- **Faster Cooling (Quicker Aircraft Turnaround Time)**

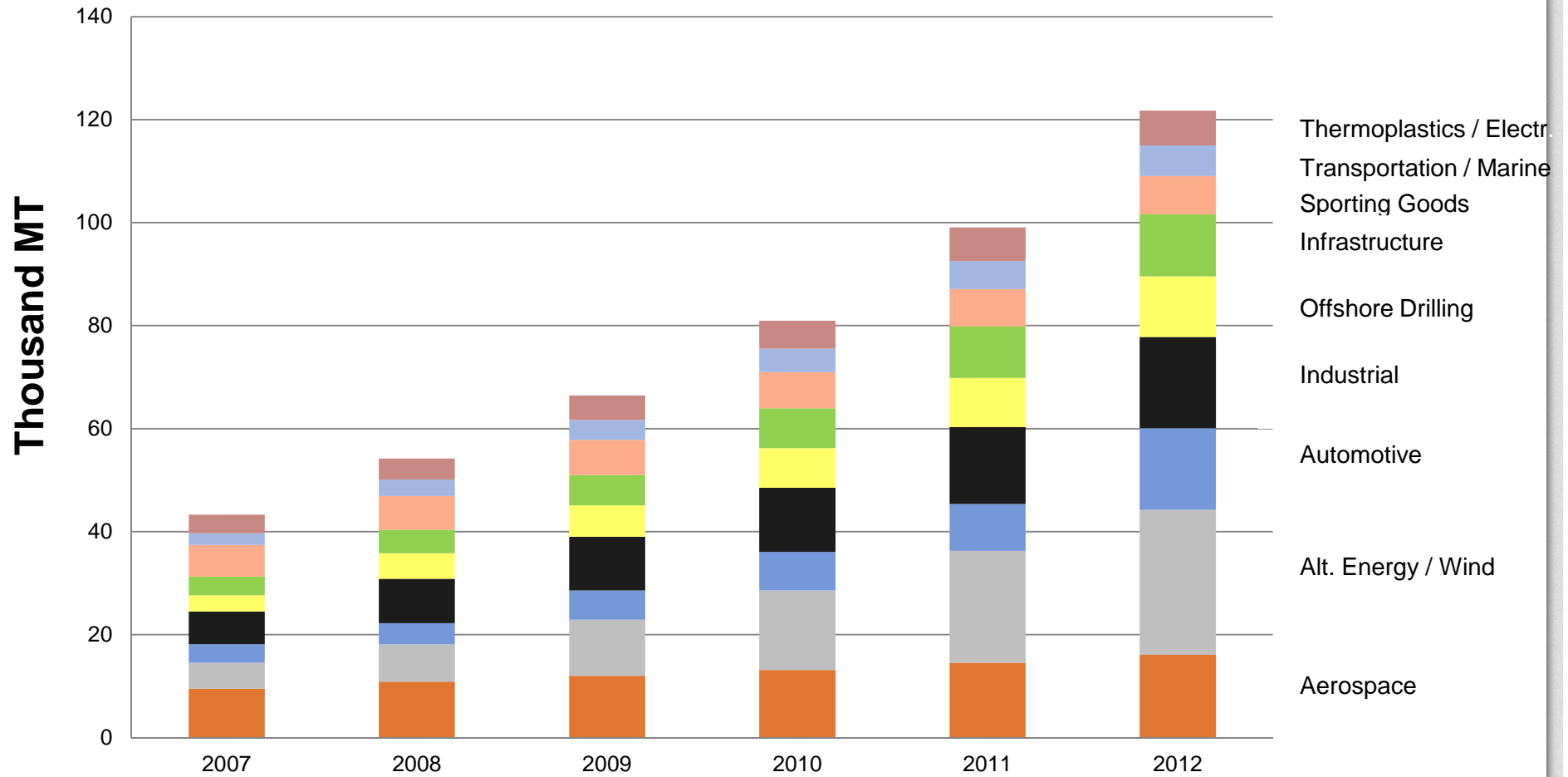


First adopted by the aircraft industry, carbon brakes are now being used in high-end automobiles. Zoltek is a major supplier for both.

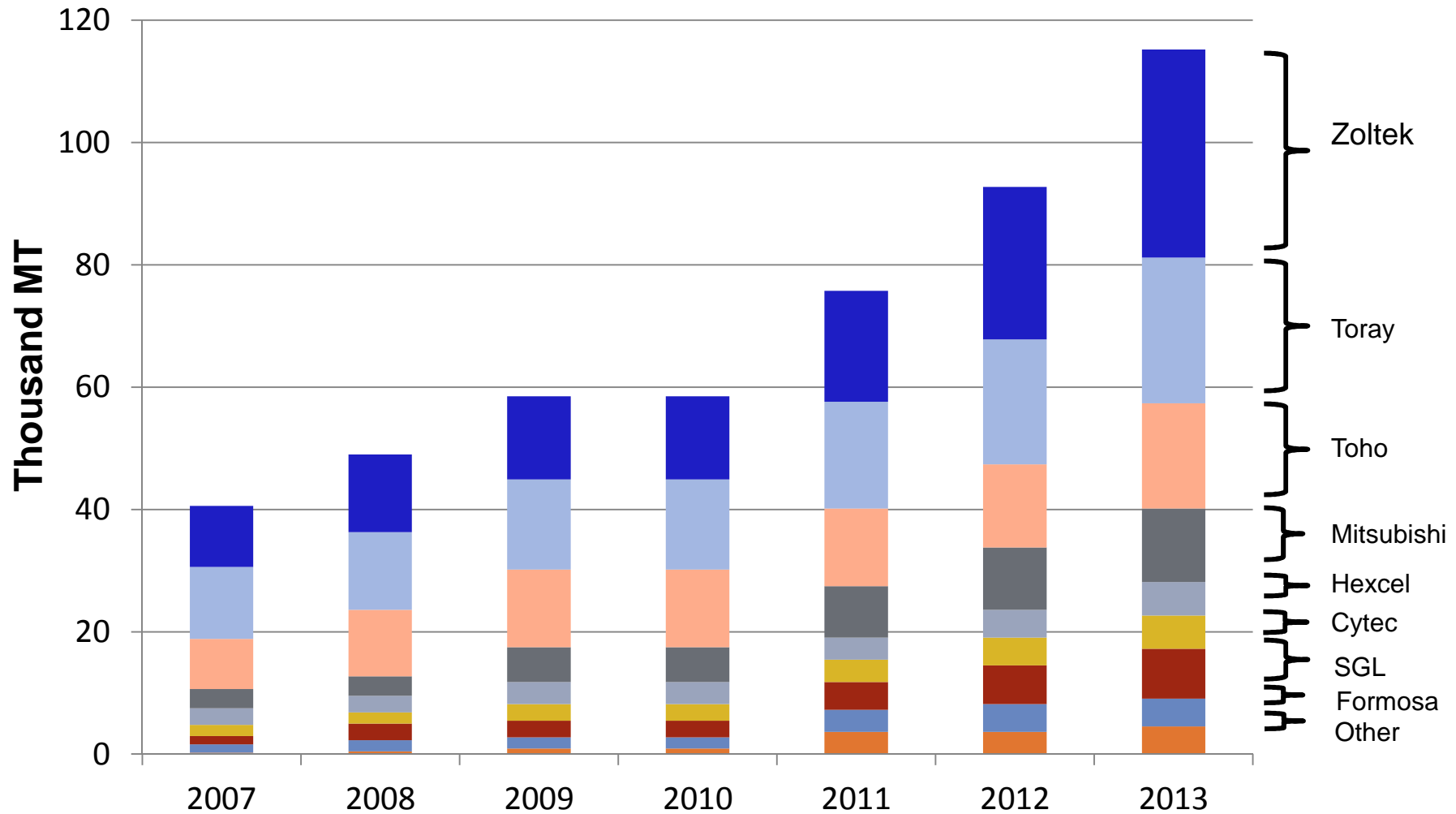
# Global Demand for Carbon Fiber



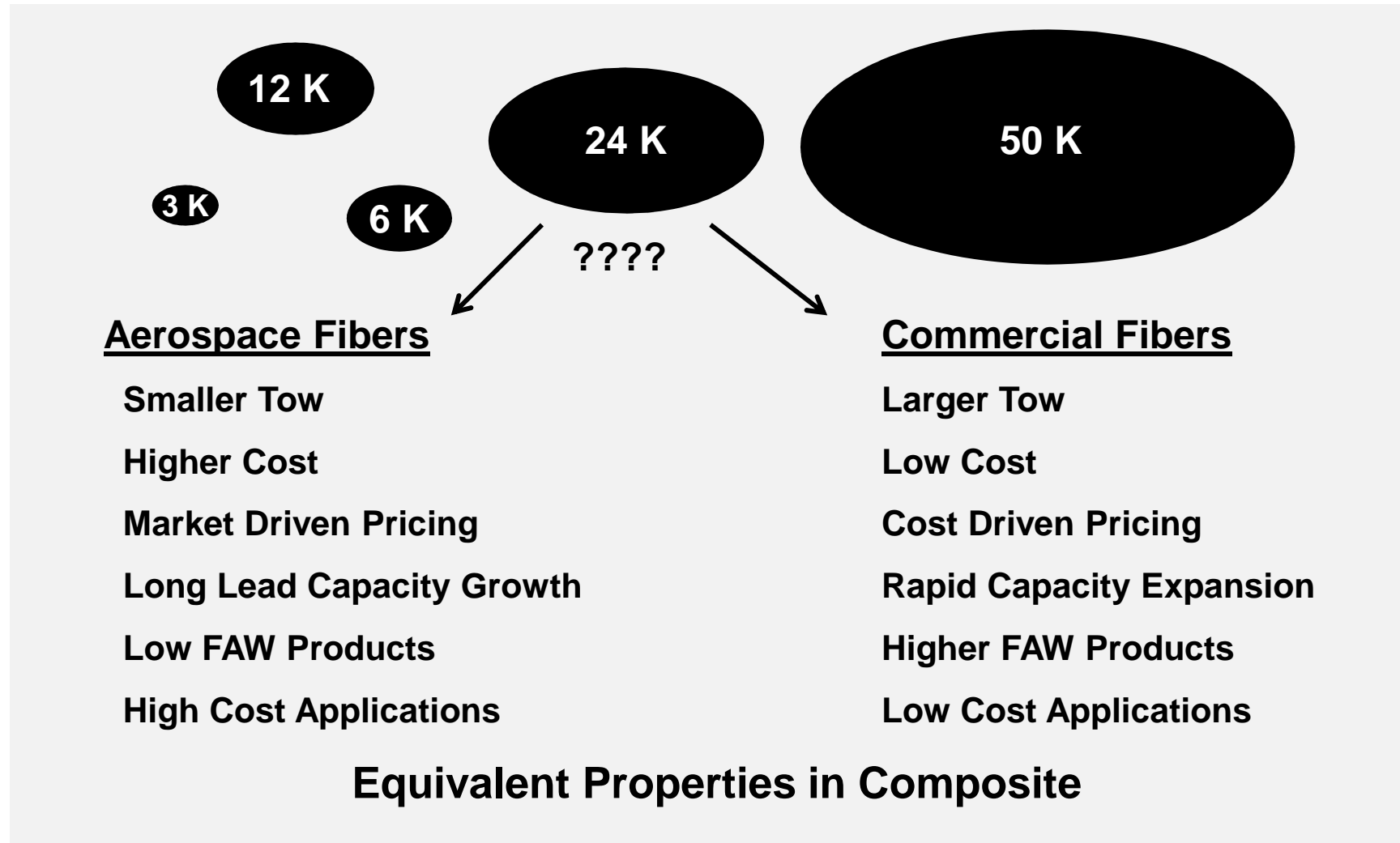
Key drivers of global demand will be energy and industrial applications



# Carbon Fiber Industry Capacity



# Commercial vs. Aerospace

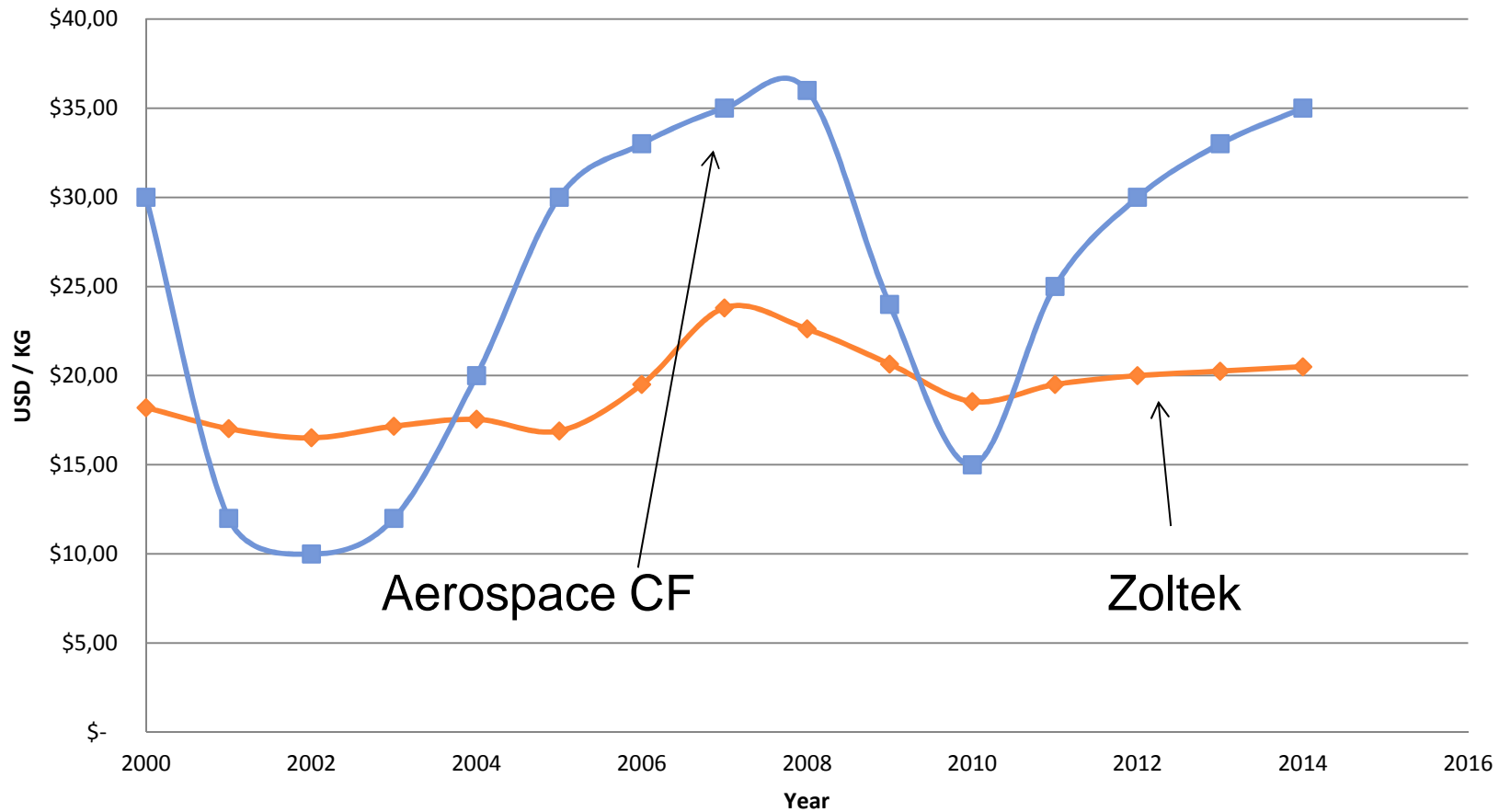


**Equivalent Properties in Composite**

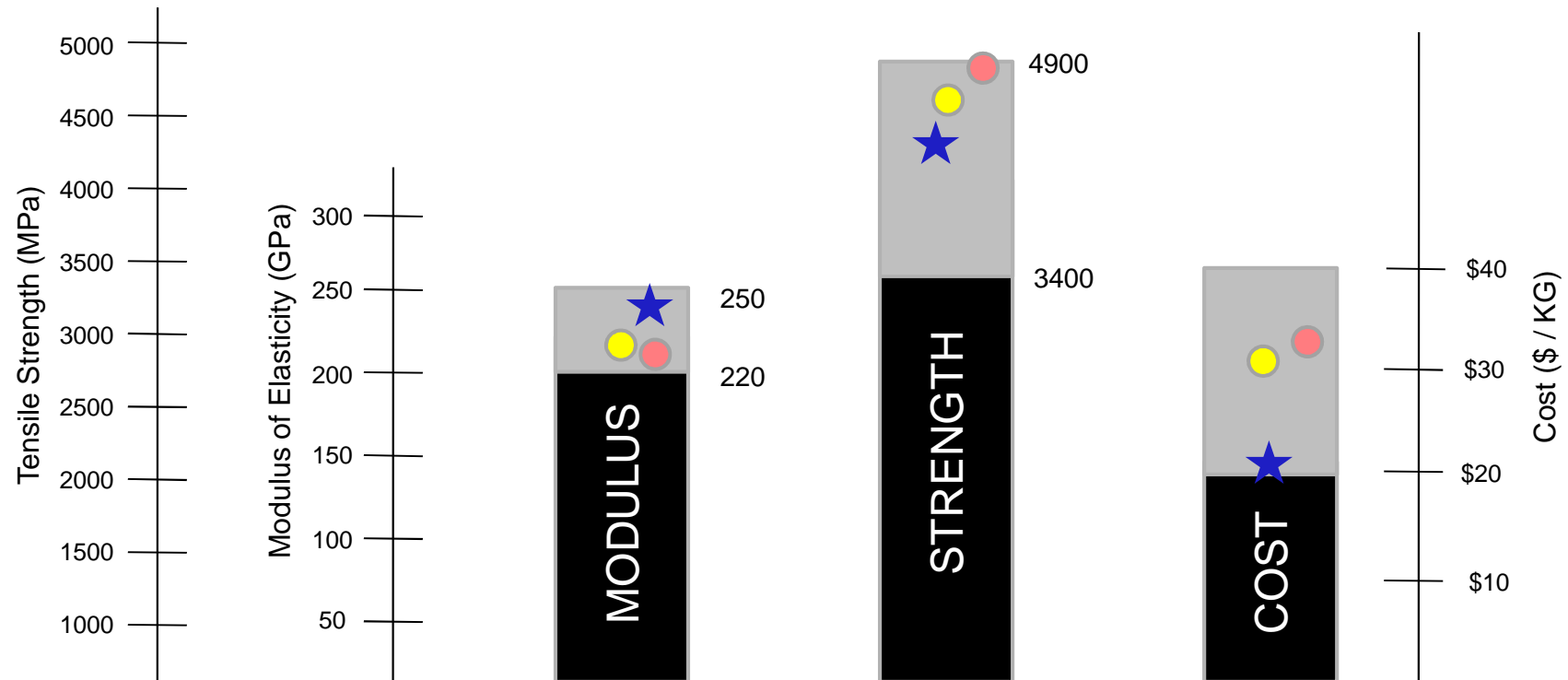
# Pricing Comparisons



### Carbon Fiber Pricing - Zoltek vs. "Aerospace"



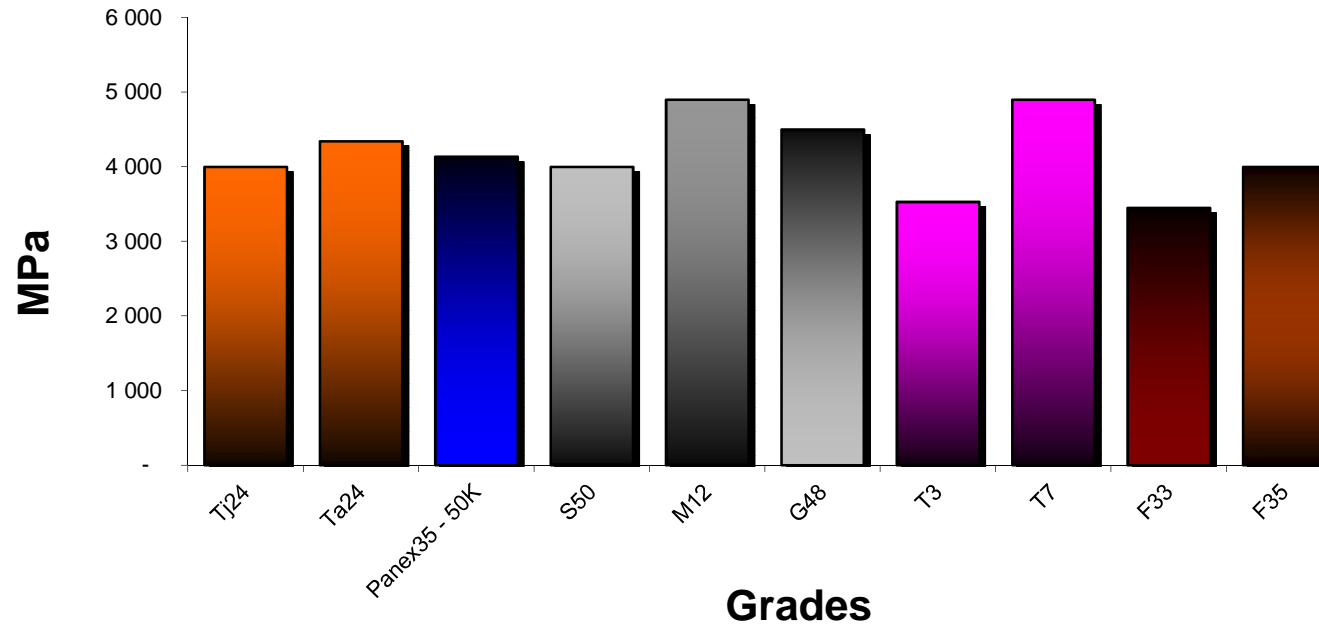
# Fiber Comparisons



Range of Standard Modulus Fibers
  Toray T 700
  MRC TR40
  PANEX 35

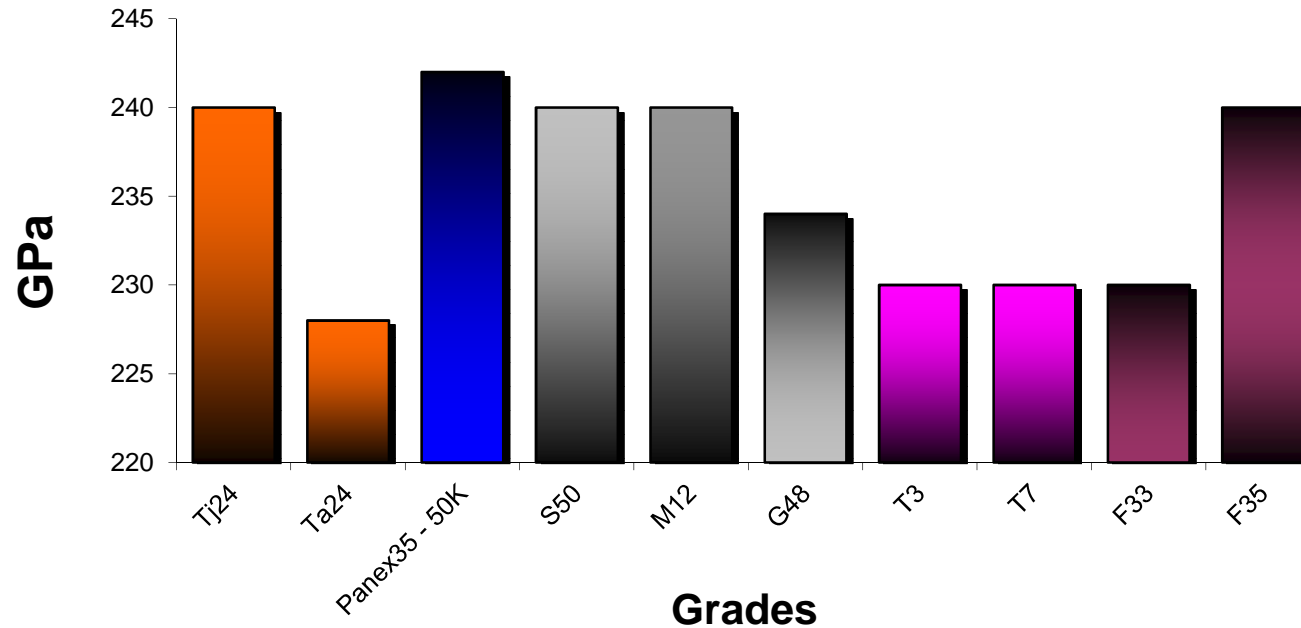


# TS Comparison – CF Filaments



As you can see Zoltek Panex 35<sup>®</sup> is a suitable product for most applications. In addition, TS of the filament will not directly correlate to the performance of the compounds (as the fiber is chopped to 6mm)

# TM Comparisons – CF Filaments



Zoltek Panex 35<sup>®</sup> focused more in TM (Tensile Modulus); it appears that Panex 35<sup>®</sup> TM is among the highest.

Even though TM of the filament shall not be directly correlate with the compounds performance, it would provides higher degree of improvement to the modulus of the final compounds.

# Products



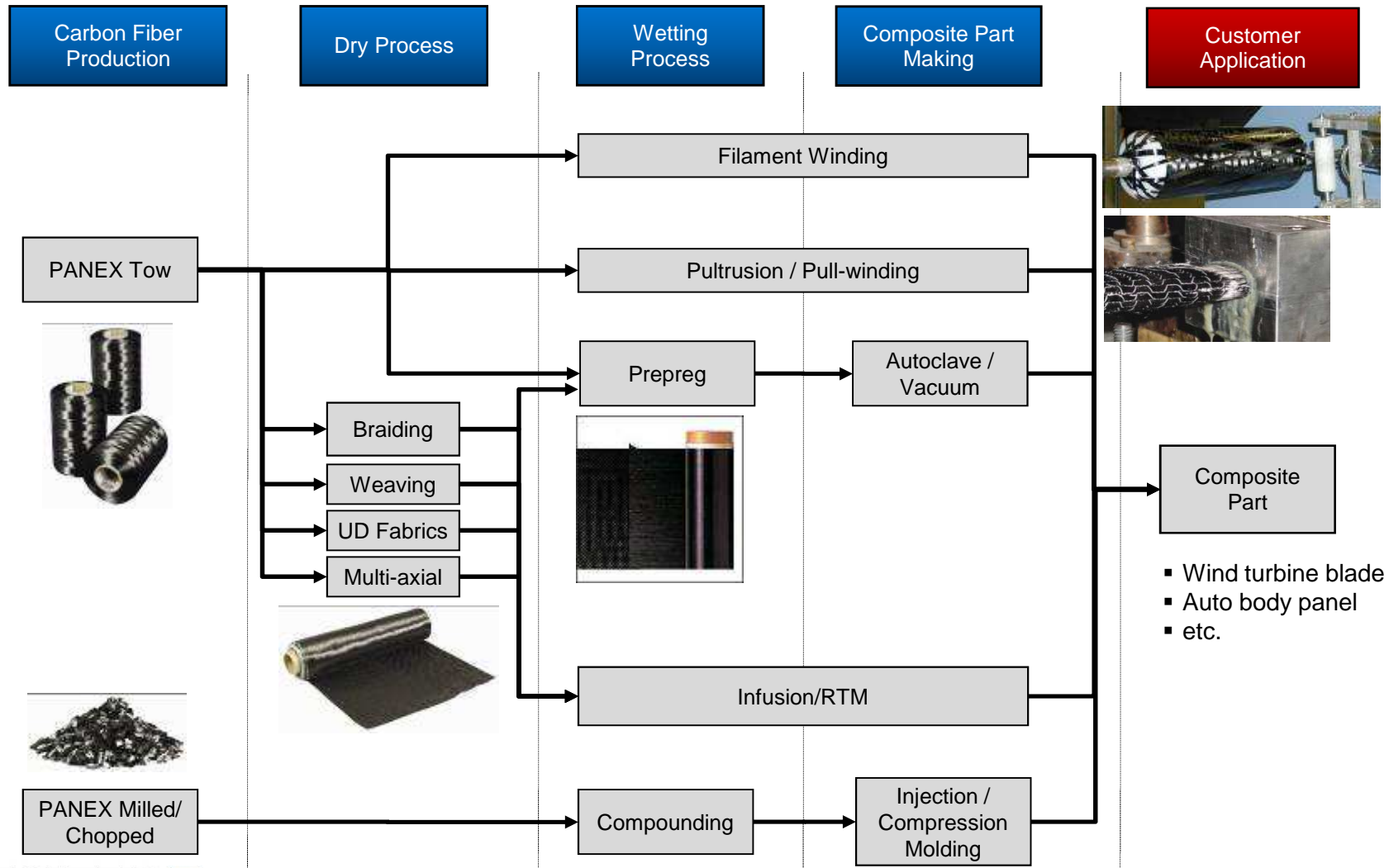
	<b>PANEX®</b>	<b>PYRON®</b>
<b>Description</b>	High Performance Carbon Fibers	Oxidized Acrylic Fibers & High Carbon Content Fibers
<b>Unique Properties</b>	<ul style="list-style-type: none"> <li>▪ High Strength &amp; Stiffness</li> <li>▪ Lightweight</li> </ul>	<ul style="list-style-type: none"> <li>▪ Friction Resistance</li> <li>▪ Flame &amp; Heat Resistance</li> </ul>
<b>Main Product Forms</b>	<ul style="list-style-type: none"> <li>▪ Tow</li> <li>▪ Chopped / Milled</li> <li>▪ Fabric</li> <li>▪ Prepreg</li> </ul>	<ul style="list-style-type: none"> <li>▪ Tow</li> <li>▪ Yarn</li> <li>▪ Staple Fiber</li> <li>▪ Fabric</li> </ul>
<b>Cost &amp; Performance</b>	Lower cost than aerospace grade, yet competitive performance	Lower cost than Nomex and Kevlar, yet competitive performance
<b>Application</b>	<ul style="list-style-type: none"> <li>▪ Wind turbine blades</li> <li>▪ Concrete reinforcements</li> <li>▪ Auto structural parts and panels</li> <li>▪ High pressure vessels</li> <li>▪ Offshore drilling equipment</li> <li>▪ Sporting goods equipment</li> </ul>	<ul style="list-style-type: none"> <li>▪ Aircraft brakes</li> <li>▪ Auto brake pads</li> <li>▪ Auto flame protection</li> <li>▪ Protective clothing</li> </ul>

# Panex<sup>®</sup> 35 – The Commercial Carbon Fiber



- **50,000 filaments**
- **7.2 micron diameter**
- **Strength = 4150 Mpa**
- **Modulus = 242 Gpa**
- **Density = 1.81 g/cc**
- **Yield = 270 m/kg**
- **Carbon Content = 95%**

# Carbon Fiber Value Chain



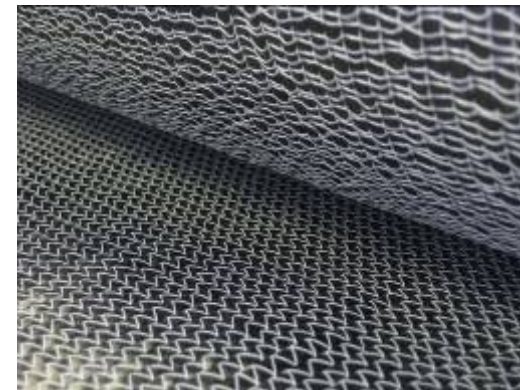
# Zoltek Infusible Carbon Fiber Fabrics



- Select fabric profiles up to 1.25 m wide
- Specifically developed for large, thick parts and vacuum infusion processing
- Typical fiber areal weights 300 – 850 gsm
- Typical  $V_f = 55\%$

## Fabric Laminate Properties\*

- $V_f = 55\%$
- Vacuum Pressure cure @ 85-120 deg C
- Laminate Density = 1.52 g/cc
- Tensile Strength = 1600 MPa
- Tensile Modulus = 125 GPa
- Compression Strength = 950 MPa
- Compression Modulus = 110 GPa



\* Normalized to 55%  $V_f$

# Standard Chopped / Milled Product



Description	Standard Fiber Length	Typical Resin Matrix
<b>Chopped Pellet (-65)</b>	6 mm (0.25 in.)	Polycarbonate, other misc. thermoplastics
<b>High Temp. Pellet (-85)</b>	6 mm (0.25 in.)	PEEK, PPS, PEI, PES, PPA, other high-temp thermoplastics
<b>Chopped Pellet (-X7)</b>	6 mm (0.25 in.)	Polyamide (Nylon)
<b>Chopped Pellet (-X6)</b>	6 mm (0.25 in.)	Polyacetal (POM)
<b>Chopped Stick (-48)</b>	8.3 mm (0.33 in.)	Nylon, PPO, other misc. thermoplastics
<b>Chopped Flake (-13)</b>	3, 6, 13 mm (0.125, 0.25, 0.5 in.)	Epoxy, Polyester, Vinyl Ester
<b>Chopped Flake Dispersible (-01, -04)</b>	3 – 50 mm (0.125 – 2.0 in.)	Water-based slurry type
<b>Milled Fiber</b>	100-300 micron (0.283 mils)	Various

# Zoltek Prepreg



- Unidirectional prepreg tapes up to 1.25 m wide
- Specifically developed for large, thick parts and vacuum pressure processing
- Typical fiber areal weights 300 – 600 gsm
- Typical  $V_f = 55-65\%$

## Laminate Properties (ZR1 Resin System)\*

- $V_f = 60\%$
- Vacuum Pressure cure @ 120 deg C
- Laminate Density = 1.54 g/cc
- Tensile Strength = 2040 MPa
- Tensile Modulus = 136 GPa
- Compression Strength = 1330 MPa
- Compression Modulus = 125 GPa



\* Normalized to 60%  $V_f$



# Zoltek Prepreg



- Unidirectional prepreg tapes up to 1.25 m wide
- Specifically developed for large, thick parts and vacuum pressure processing
- Typical fiber areal weights 300 – 600 gsm
- Typical  $V_f = 55-65\%$

## Laminate Properties (ZR6 Resin System)\*

- $V_f = 60\%$
- Vacuum Pressure cure @ 85-120 deg C
- Laminate Density = 1.55 g/cc
- Tensile Strength = 1859 MPa
- Tensile Modulus = 131 GPa
- Compression Strength = 1327 MPa
- Compression Modulus = 126 GPa



\* Tested at IMA-Dresden, made with 3800 Mpa strength fiber



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Leaders in the Commercialization of Carbon Fibre

Thank you for your attention!