

INNEGRA TECHNOLOGIES

Corporate Presentation



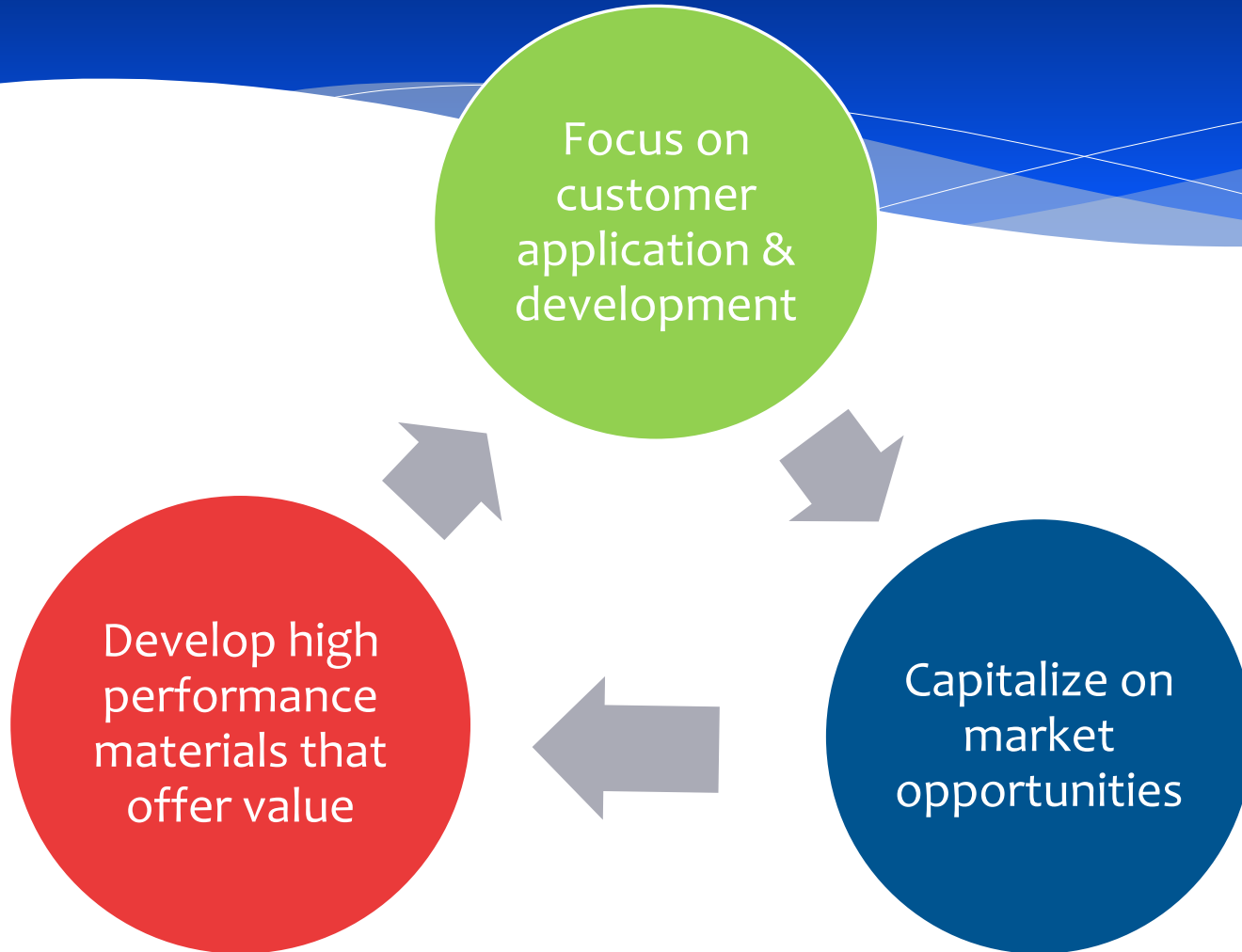
Our Company





- Innegra Fiber was developed in Greenville SC 2004-2008
- Commercial production began 2009
- Extensive domestic & international patent portfolio

INNEGRA TECHNOLOGIES, LLC



Markets

APPLICATIONS

Aerospace
Automotive
Ballistics
Construction
Industrial
Luggage & Cases
Marine
Military
Radomes
Ropes & Netting
Sporting Goods

Phase 1

- Sporting Goods
- Luggage & Cases
- Ropes & Netting

Phase 2

- Automotive
- Industrial
- Powered Marine

Phase 3

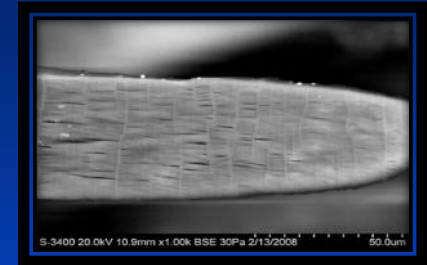
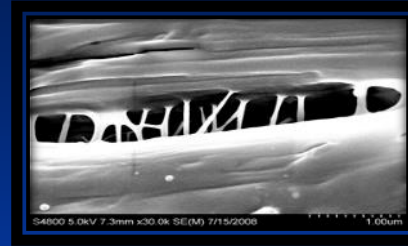
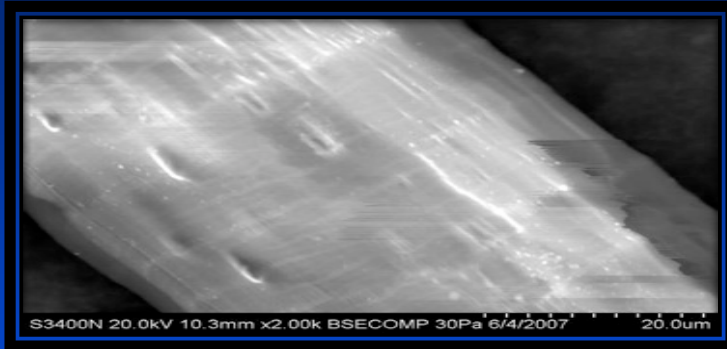
- Aerospace
- Ballistic/Blast
- Medical
- Military/Protective

Our Products

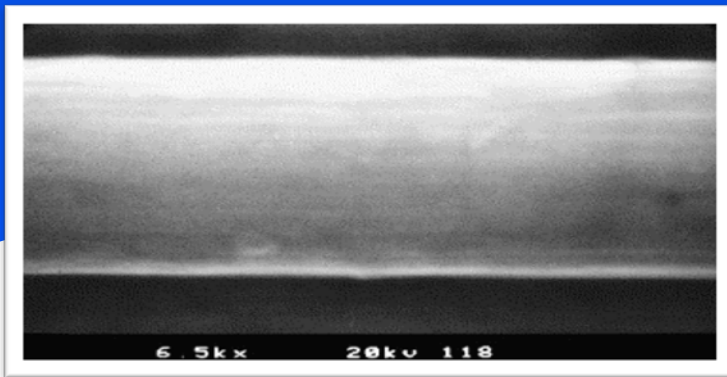


INNEGRA™ FIBER CHARACTERISTICS

Innegra Filament



Carbon Filament



- Excellent Dielectric Properties
- Highly Crystalline
- Hydrophobic
- Low Creep
- Low Density
- Low Elongation
- Micro Voids in Structure
- Olefin Based Chemistry

FIBER COMPARISONS

		Aramid	Basalt	Carbon (PAN)	E-Glass	S-Glass	UHMWPE	Innegra	Quartz
Density	g/cm ³	1.44	2.70	1.78	2.54	2.48	0.97	0.84	2.20
Tensile Strength	MPa	2400 - 3600	4840	5313	2600	4800	2200 - 3900	667	6000
Modulus	GPa	60 - 120	89	292	72	85	65 - 132	15	72
Elongation at Break	%	2.2 - 4.4	3.2	1.8	4.0	5.5	3 - 4	9.5	3.0
UV Resistance		Poor	Excellent	Excellent	Excellent	Excellent	Very Good	Very Good	Excellent
Solvent Resistance		Fair	Excellent	Very Good	Very Good	Very Good	Excellent	Excellent	Excellent
Moisture Absorption	%	3.2 - 7.0	0.2 - 12.0	0	0.1	0.1	< 0.1	< 0.1	0
Max Processing Temp	°C	450 Td = 427 - 500	980 Tm =	3500 Td = 3700	730 Tm = 825	850 Tm =	140 Tm = 144 - 152	150 Tm = 162 - 164	1070 Tm =
Dielectric Constant (Dk)		3.4	2.0 - 3.2	conductive	6.2	5.2	2.25	2.2	3.7
Dissipation Factor (Df)		0.014-0.01	0.003 - 0.015	conductive	0.003-0.004	0.002	0.0002	0.0009	0.0001
Coefficient of Linear Thermal Expansion	ppm / K	-4.0 to -4.9	8.0	-1.1	5.4	2.9	-12.0	-8.0	0.54

Data for fibers other than Innegra are from manufacturer literature.

AWARD WINNING INNEGRA™ H FIBER

- Innegra S fiber hybridized at the filament level with high modulus fibers
- Can be made into reinforcements as would standard fibers
- Fiber ratios can be adjusted as specified
- Hybrid fiber overcomes traditional resin bonding issues with olefin based fibers
- Increased bulk allows rigidity to be achieved with fewer layers
- High modulus fibers in an intimate blend vastly improves damage tolerance and impact resistance

Strength & Safety = Best of Both Worlds

BY DEFINITION

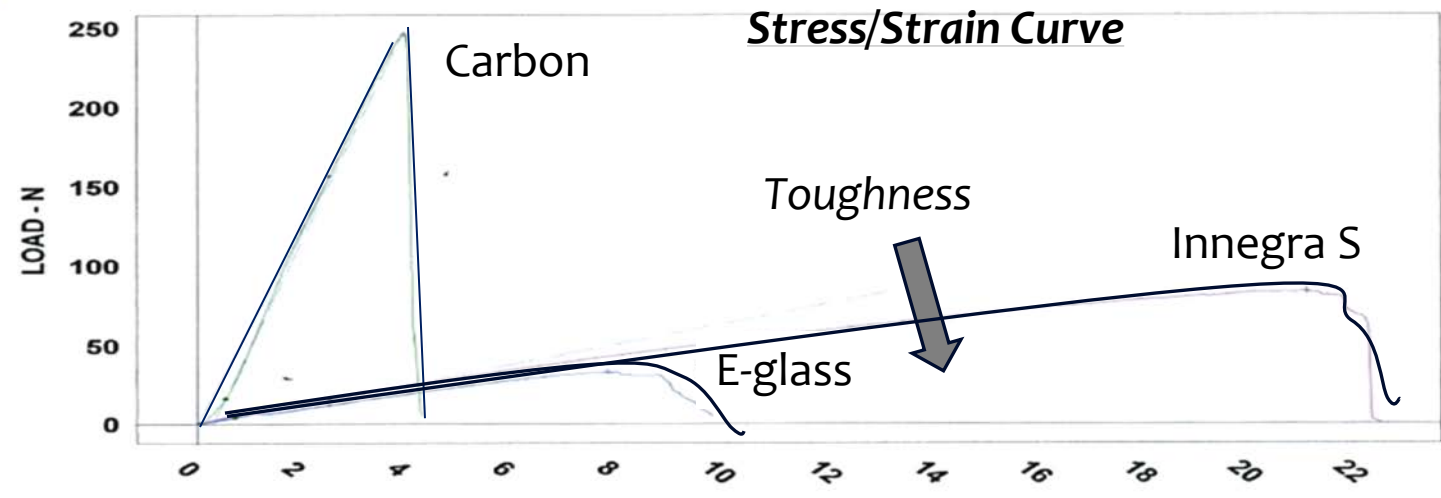
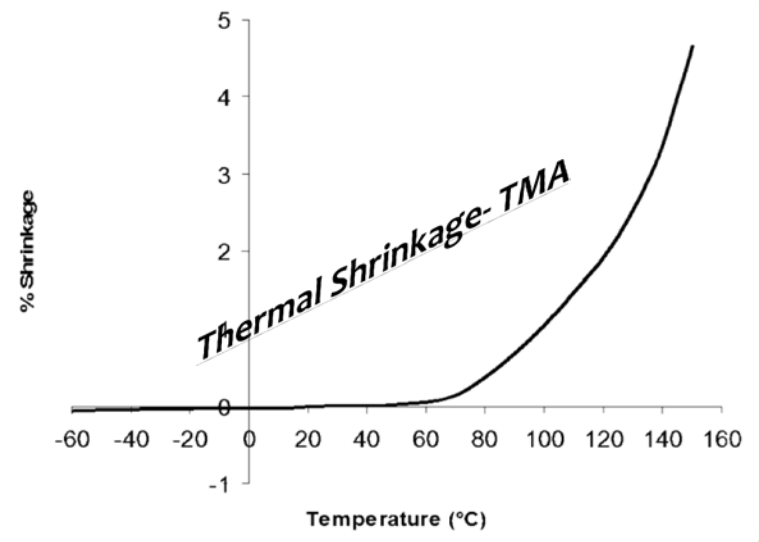
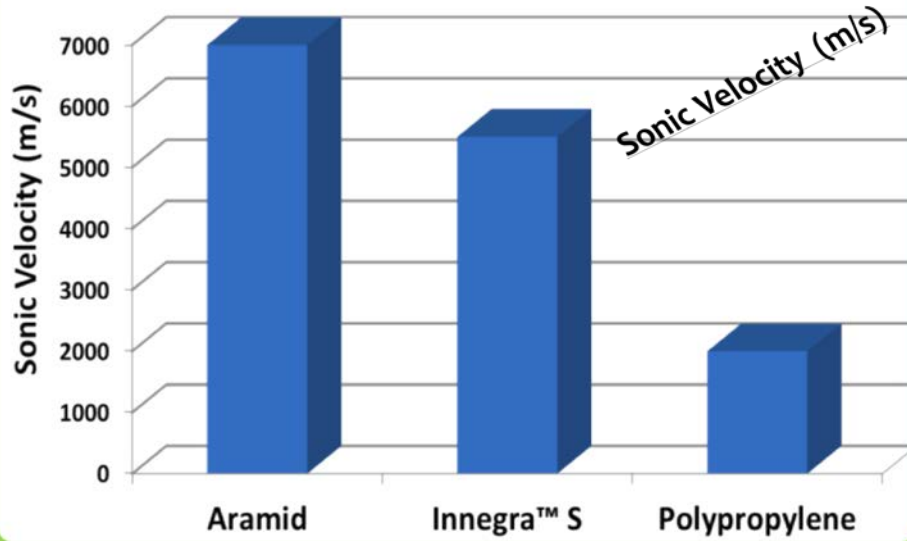
Toughness: durable, not easily broken or cut, capable of great endurance.

Modulus: the ratio of the stress expressed in either force per unit linear density or force per unit area of the original specimen.

Tensile Strength: ability of a material to withstand a longitudinal stress, expressed as the greatest stress that the material can stand without breaking.

Innegra™ S fiber exhibits toughness and ductility, rather than strength and stiffness.

Data from US Army Labs - Natick

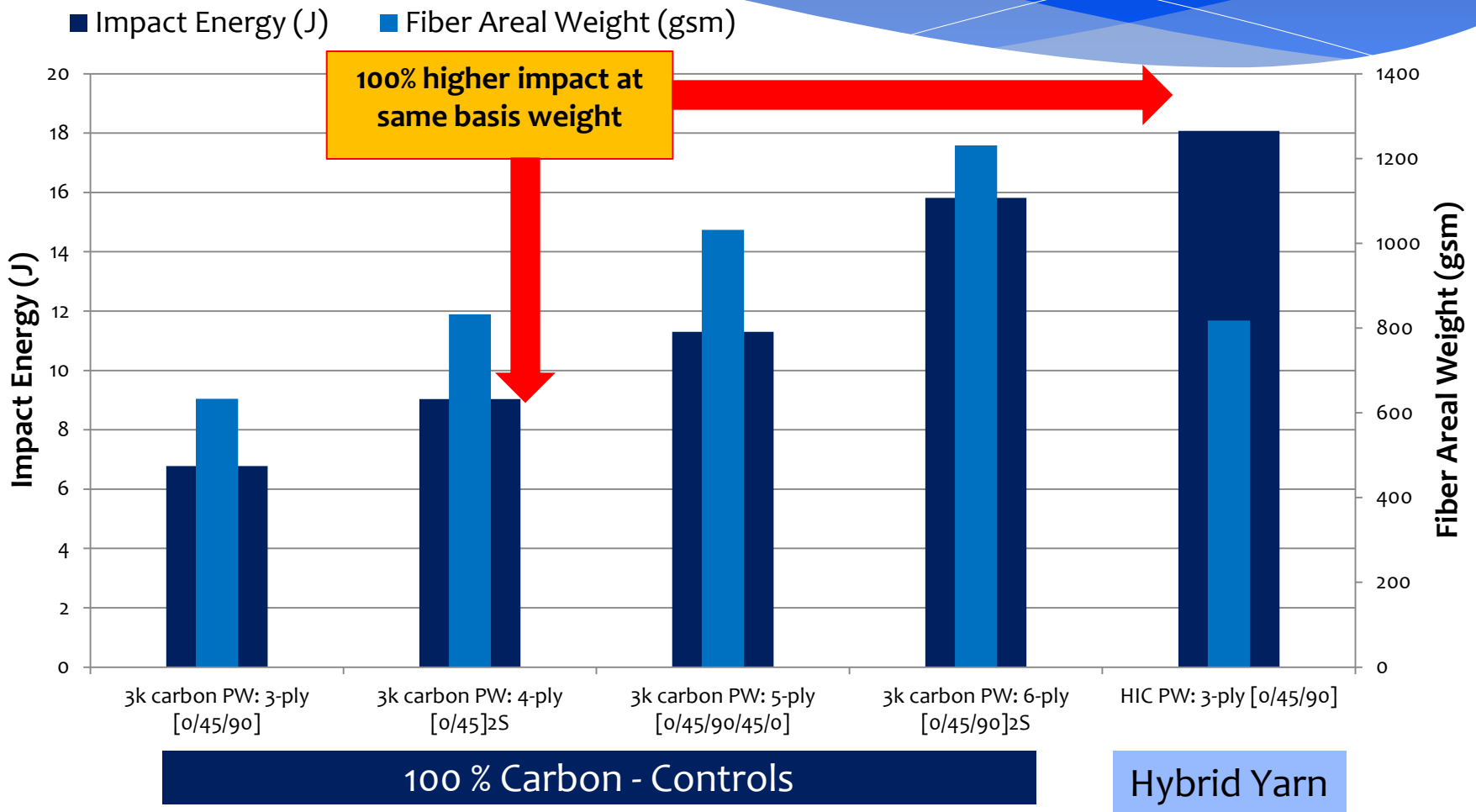


Yarn tensile testing @ 250mm gage length, 125 mm/min rate

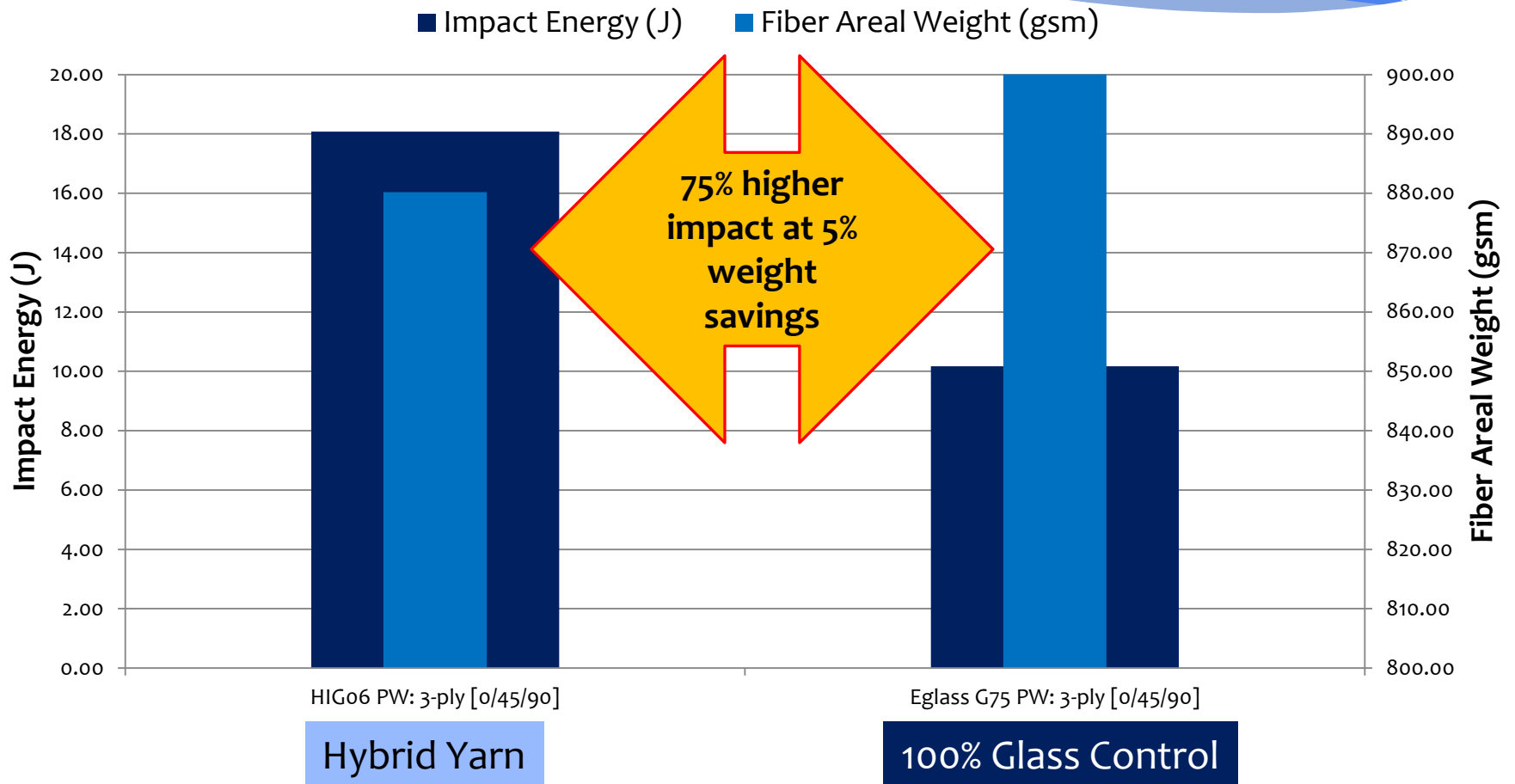
Our Benefits



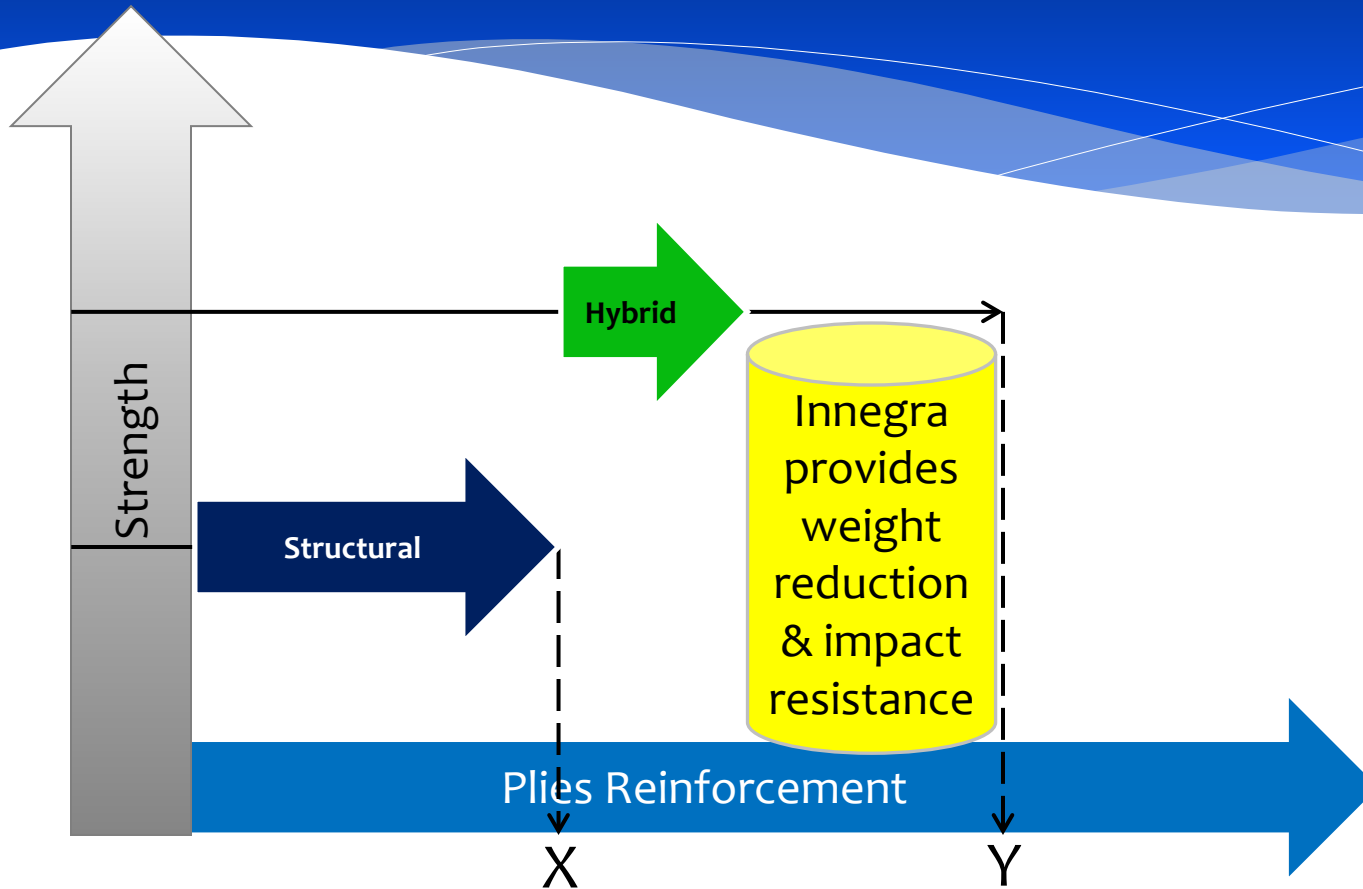
Impact Energy Absorption - Carbon



Impact Energy Absorption - Glass



Reducing the Cost of Over-Engineering



X = structural requirement

Y = required to achieve desired impact strength

$Y - X$ = effective over-engineering of structure

IMPACT PROPERTIES

How many layers of carbon would be needed to give equivalent performance on hammer impact test? ***example of over engineering**

1 layer - Carbon
1 layer - Innegra



2 layers Carbon

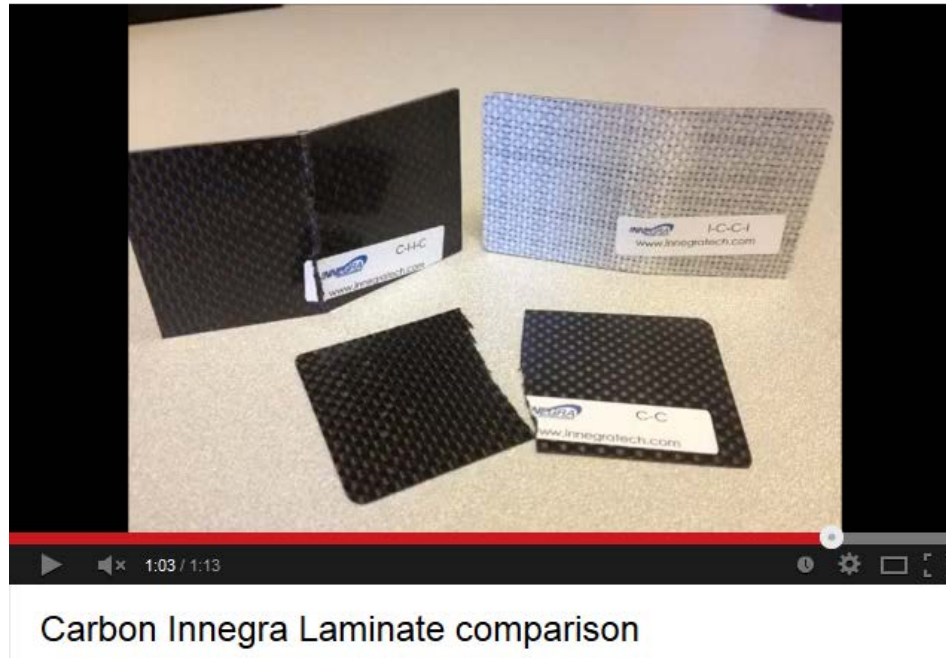


Innegra adds impact resistance

Innegra Value Proposition

Aramid vs Innegra	Carbon vs Innegra	Glass vs Innegra
<p><u>Benefits</u></p> <ul style="list-style-type: none">• Impact Resistant• Durability• Weight• Cost• Reduce Catastrophic Failure• Dielectric Properties• Moisture Resistant• Ease of Processing	<p><u>Benefits</u></p> <ul style="list-style-type: none">• Impact Resistant• Durability• Weight*• Cost• Reduce Catastrophic Failure• Dielectric Properties• Vibration Dampening• Design in flex	<p><u>Benefits</u></p> <ul style="list-style-type: none">• Impact Resistant• Durability• Weight• Reduce Catastrophic Failure• Dielectric Properties• Vibration Dampening

Innegra Demonstration Video



Carbon Innegra Laminate comparison

(Hyperlinks to YouTube)

SAFETY

Would Innegra fiber have made a difference?

- * Increase damage tolerance
- * Increase impact resistance
- * Reduce catastrophic failure



Value & Versatility

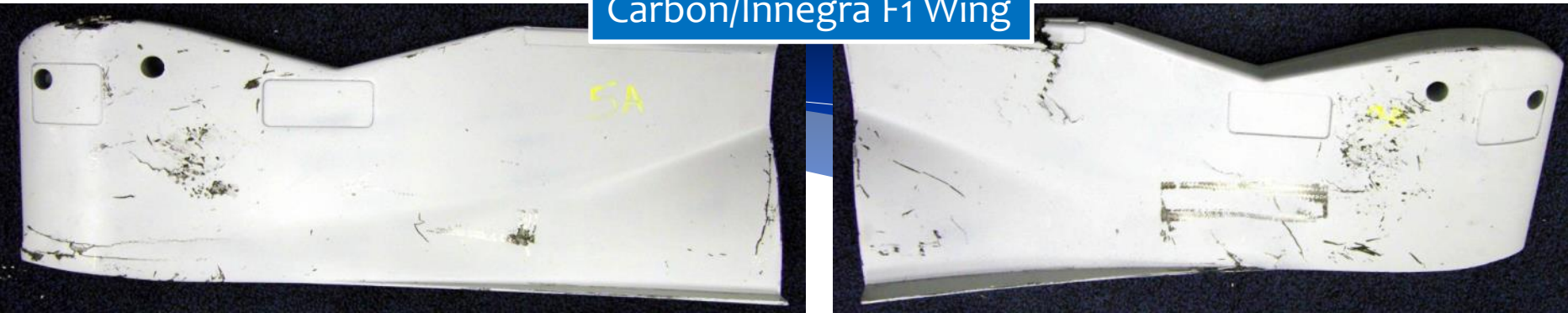


Benefits of using Innegra fiber

- | | |
|-----------------------|-----------------------------------|
| • Biologically stable | • Hydrolytically stable |
| • Chemically stable | • Lightweight |
| • Cost effective | • Low creep |
| • Ductile | • Recyclable |
| • Extended part life | • Low temperature stability |
| • High sonic velocity | • Moisture resistant |
| • Tear resistant | • Moldable |
| • Tough | • Vibration dampening |
| • Washable | • Excellent Dielectric Properties |

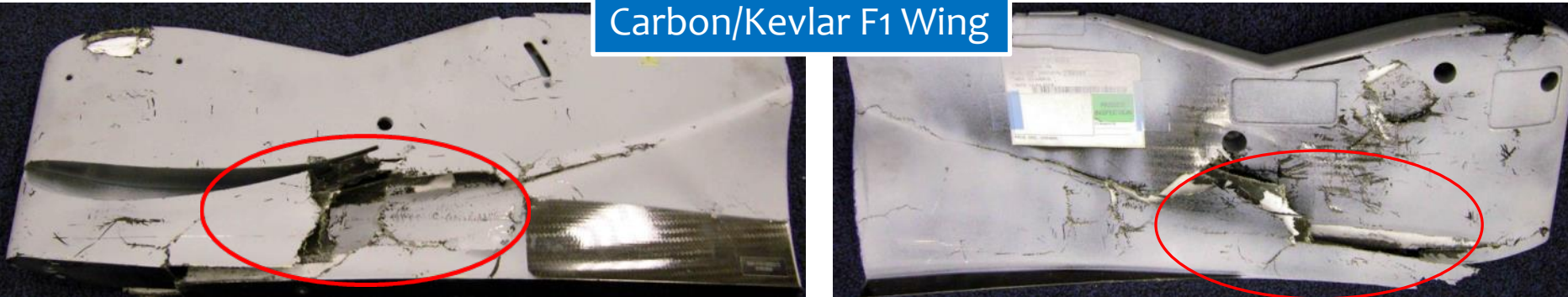


Carbon/Innegra F1 Wing



“falling weight impact tests and the mallet tests both showed the Innegra material to be equal to and generally superior to the Kevlar equivalent. This was manifested both in terms of resistance to damage and minimizing the size and quantity of debris”. –G. Savage

Carbon/Kevlar F1 Wing



**EVALUATION OF POLYPROPYLENE FIBER COMPOSITES FOR USE IN
ACCIDENT DEBRIS RETENTION**
by Gary Savage, PhD

What you need to know about working with Innegra™ fiber.

- Social fiber- works well with other fibers
- Think hybrid-especially for first time users
- Learning curve with new material
- Different products = different recipe
- Max processing temperature is 150°C/302°F
- Low viscosity resins are preferred
- Increase resin content 5-8%
- Calculate resin by volume not weight
- Fabric will not change color when wet out
- Will add ductility
- www.innegrates.com/technical
- Resin compatibility testing results located on on the technical page, along with laminate data
- Innegra team is here to assist you with your application



REVIEW

Why use Innegra Fiber?

Safety

- Increase damage tolerance
- Increase impact resistance
- Reduce catastrophic failure
- Safer parts

Value

- Cost effective
- Extend part life
- Lightweight
- Tough
- Vibration Dampening

Versatility

- Bio stability
- Chemical resistant
- Ductile
- Hydrophobic
- Low temp stability
- Moldable
- Recyclable
- Tear resistant
- Washable

Let the benefits of Innegra™ fiber set you apart.

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*Thank you for your time...
and interest in Innegra™ fiber.*



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