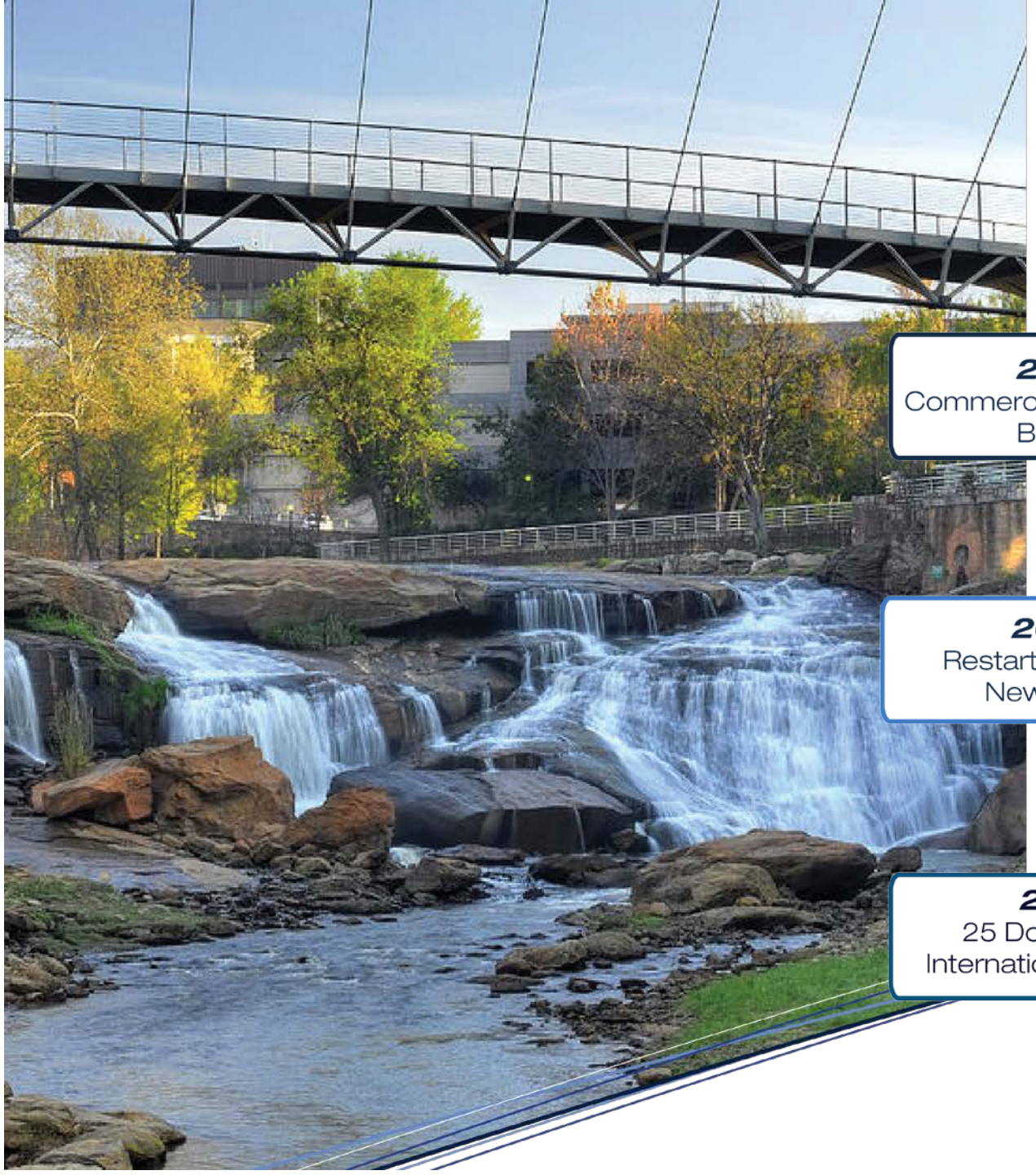
INNEGRA TECHNOLOGIES™

High Performance Fiber

Corporate Presentation



2004

2004-2008
Innegra™ S Fiber Developed in Greenville, SC

2009
Commercial Production Began

2010
Production Halted

2012
Restarted Under New Entity

2013
Launched Innegra™ H Fiber Product Line

2015
25 Domestic & International Patents

Present

INNEGRA™
High Performance Fiber

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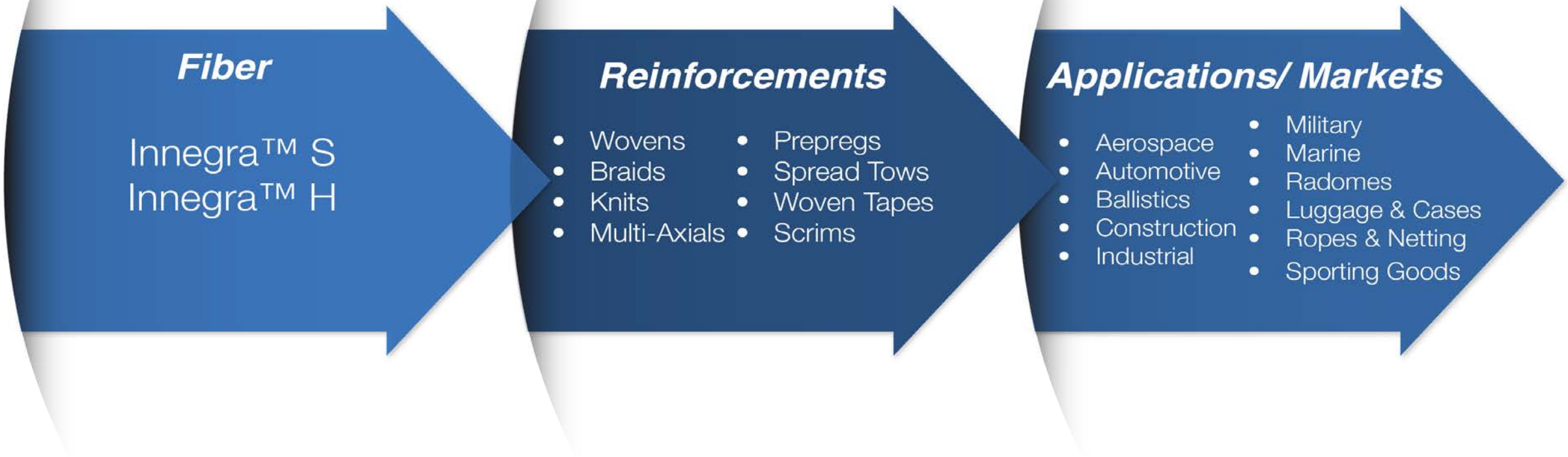
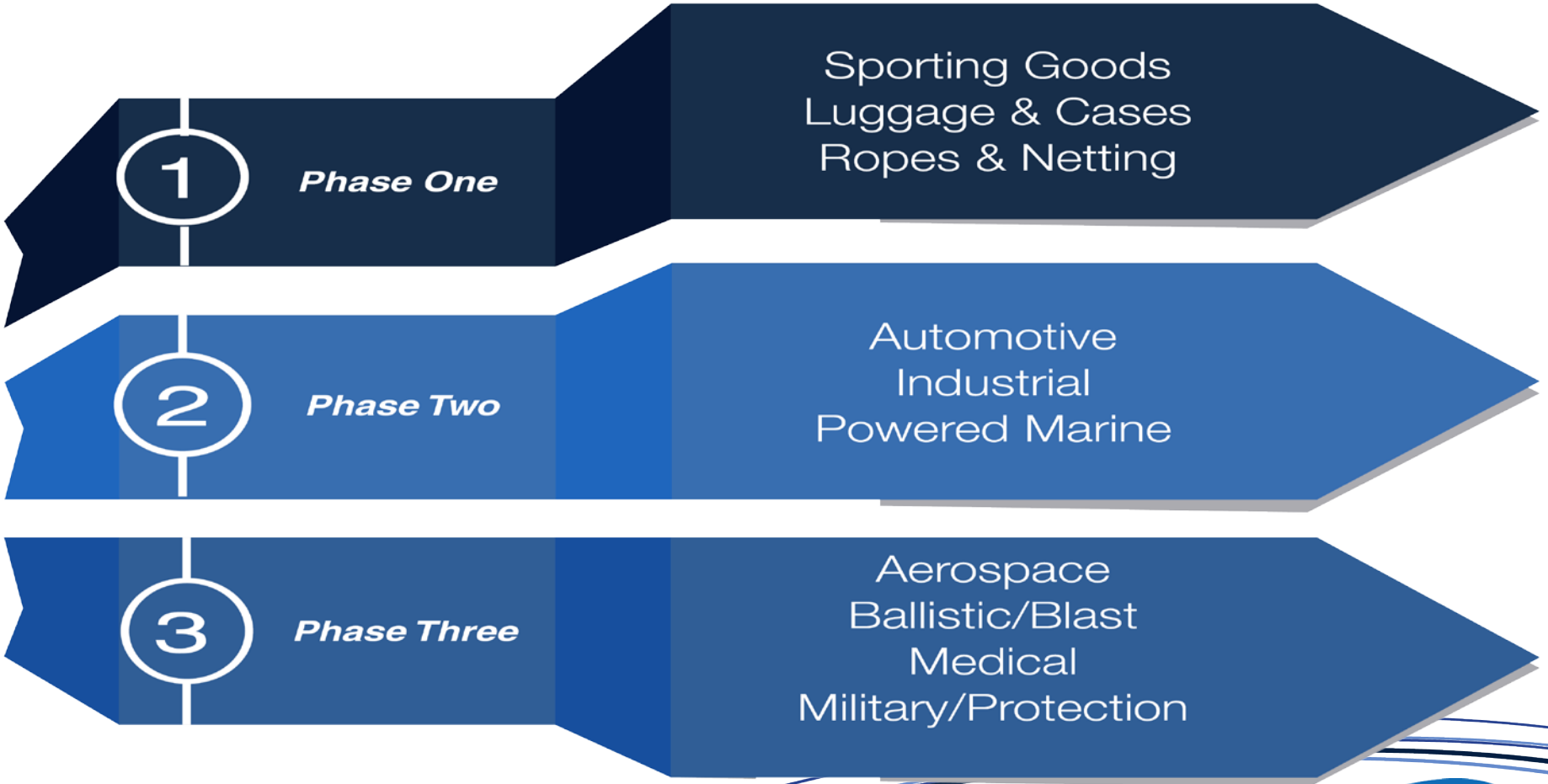
High Performance Fiber

Fiber to Commercial Products



INNEGRA™
High Performance Fiber

Market and Applications



INNEGRA™
High Performance Fiber

Products

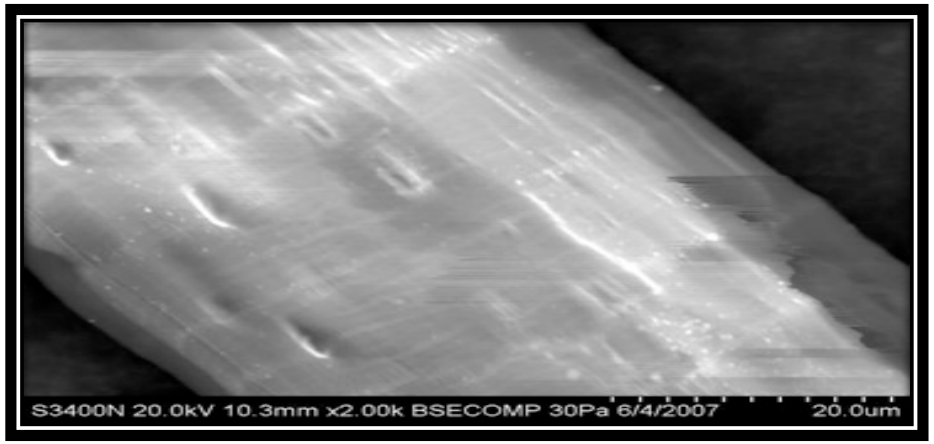
What is Innegra™?

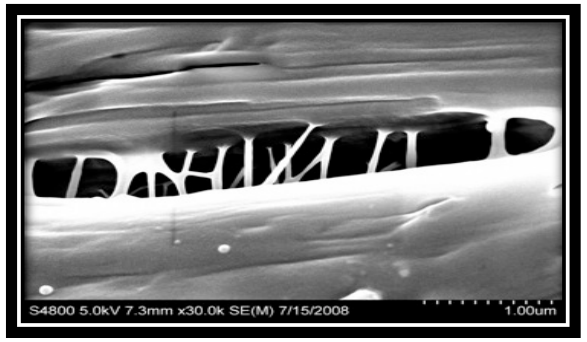
Innegra™ S is an olefin based high performance yarn used most often in conjunction with a high modulus fiber to increase toughness, durability, damping, and in some cases, reduce weight.

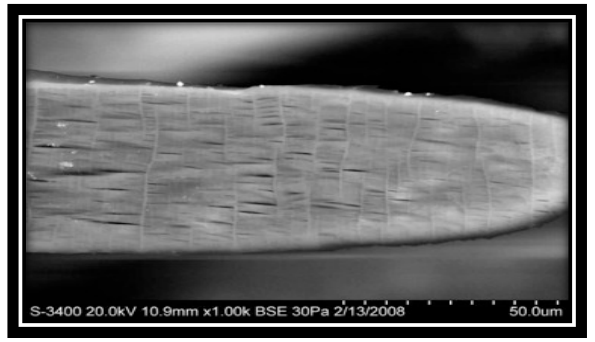
Innegra™ H is a hybridized yarn containing Innegra and a high modulus fiber (carbon, glass, basalt, or aramid). These fibers are co-mingled at the filament level to combine the properties of both fibers in the same plane, resulting in increased performance.

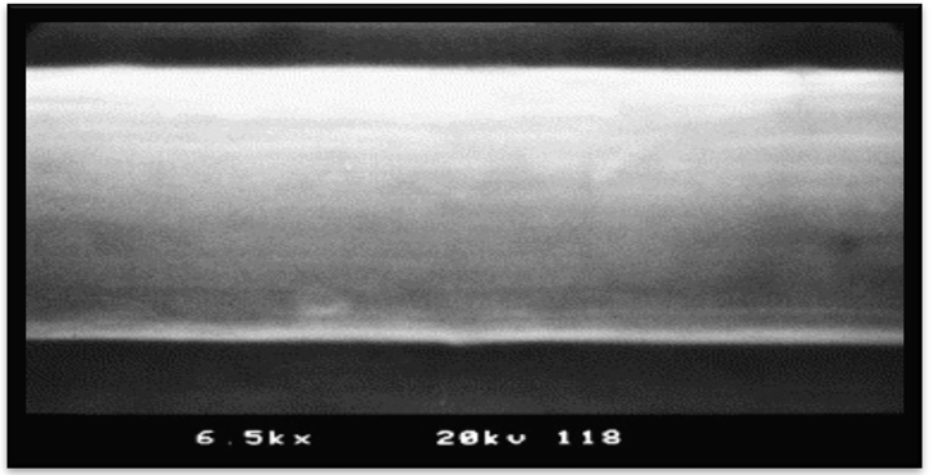
INNEGRA™
High Performance Fiber

Innegra™ Characteristics









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

INNEGRA™
High Performance Fiber

Fiber Comparisons

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

By definition…

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

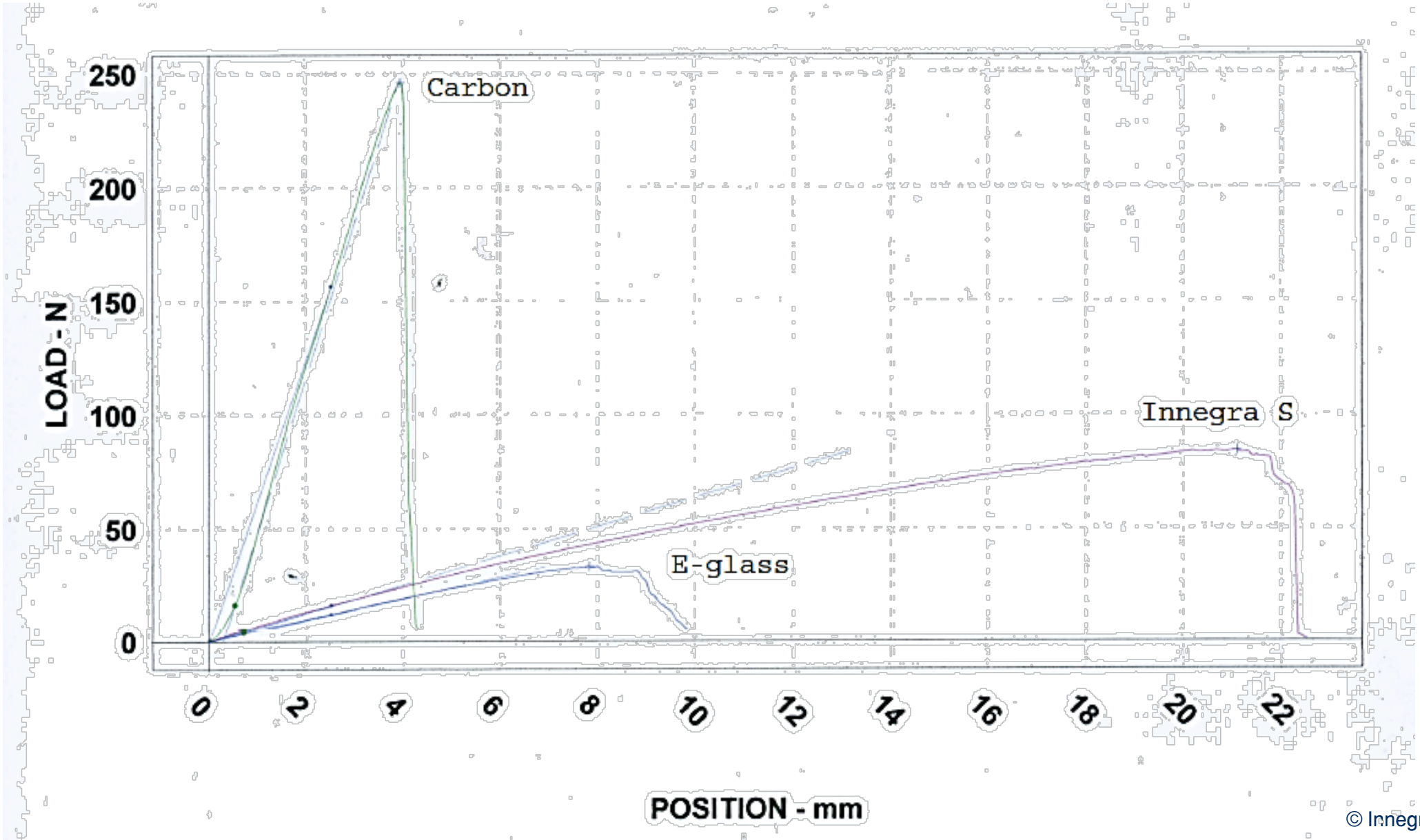
Toughness: Durable, not easily broken or cut, capable of great endurance.

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

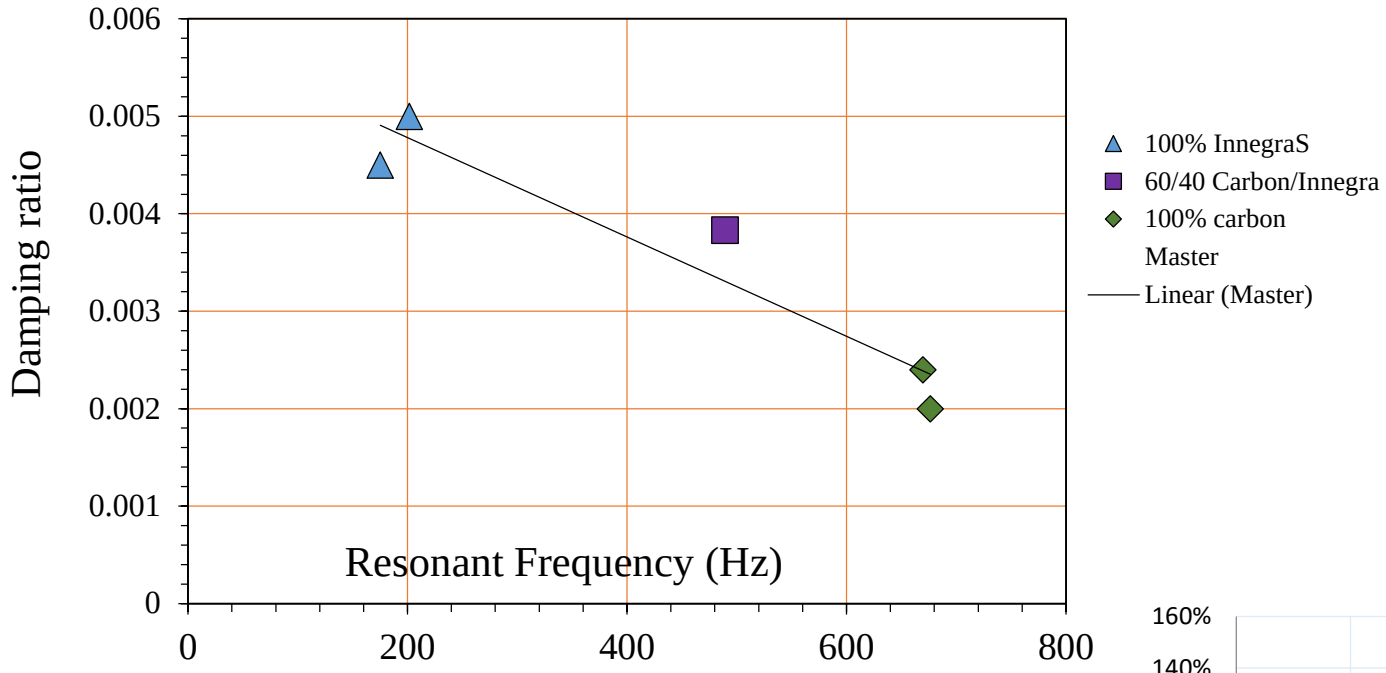
Tensile Strength: Ability of a material to withstand a longitudinal stress, expressed as the greatest stress that the material can stand without breaking.

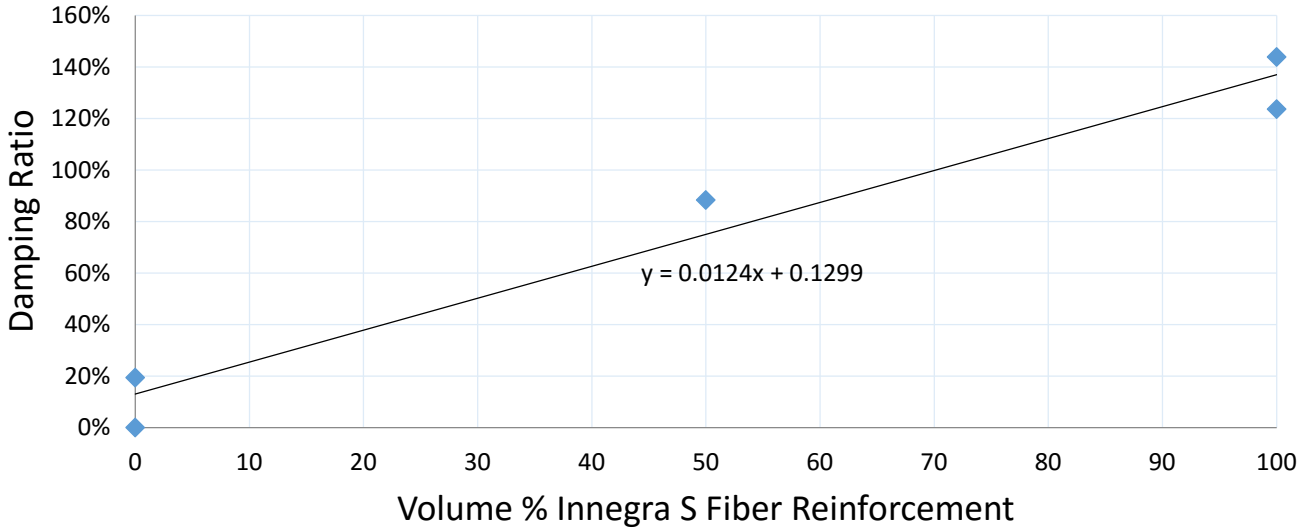
INNEGRA™
High Performance Fiber

Stress Strain Curve

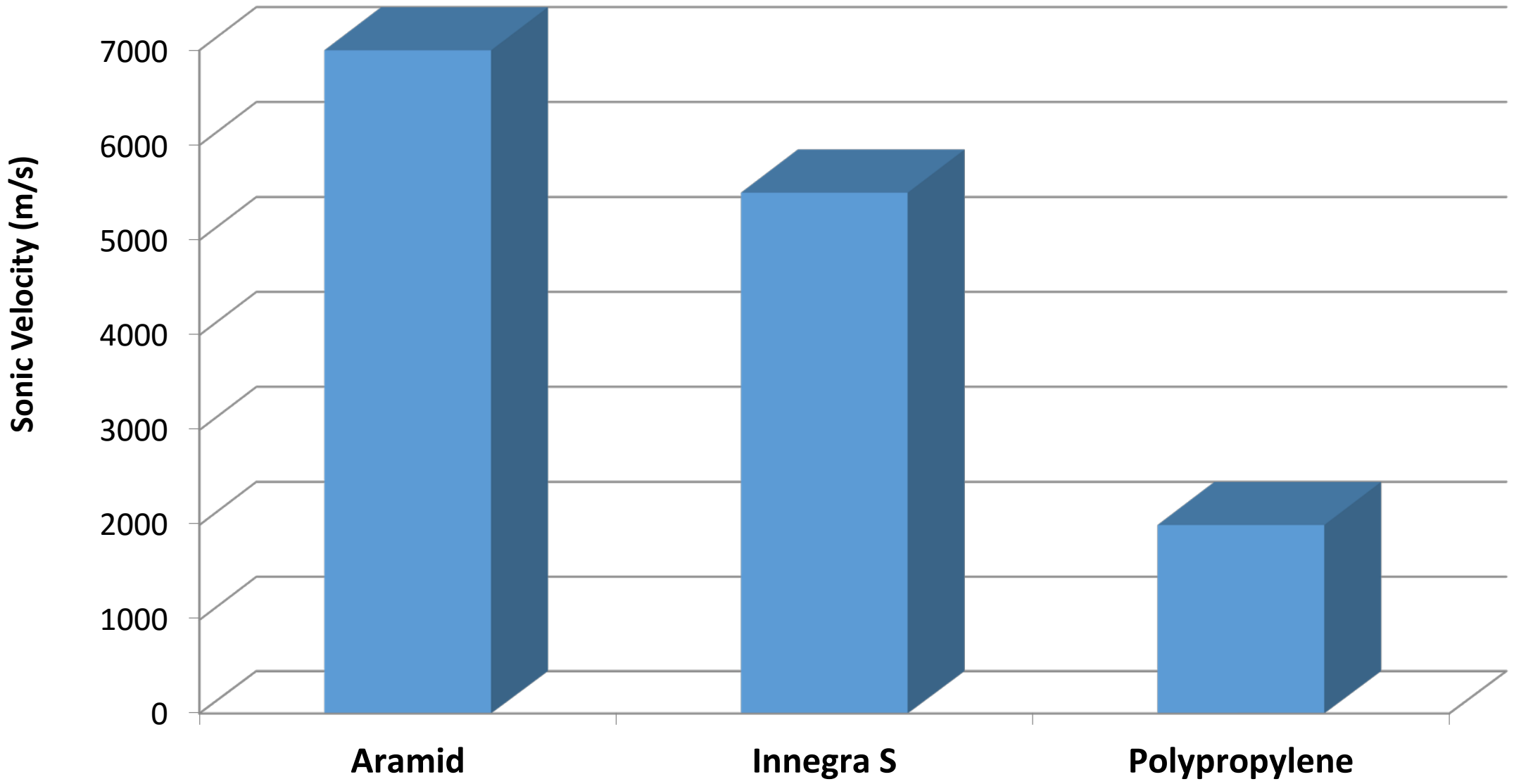


Vibration Damping of Innegra™ S

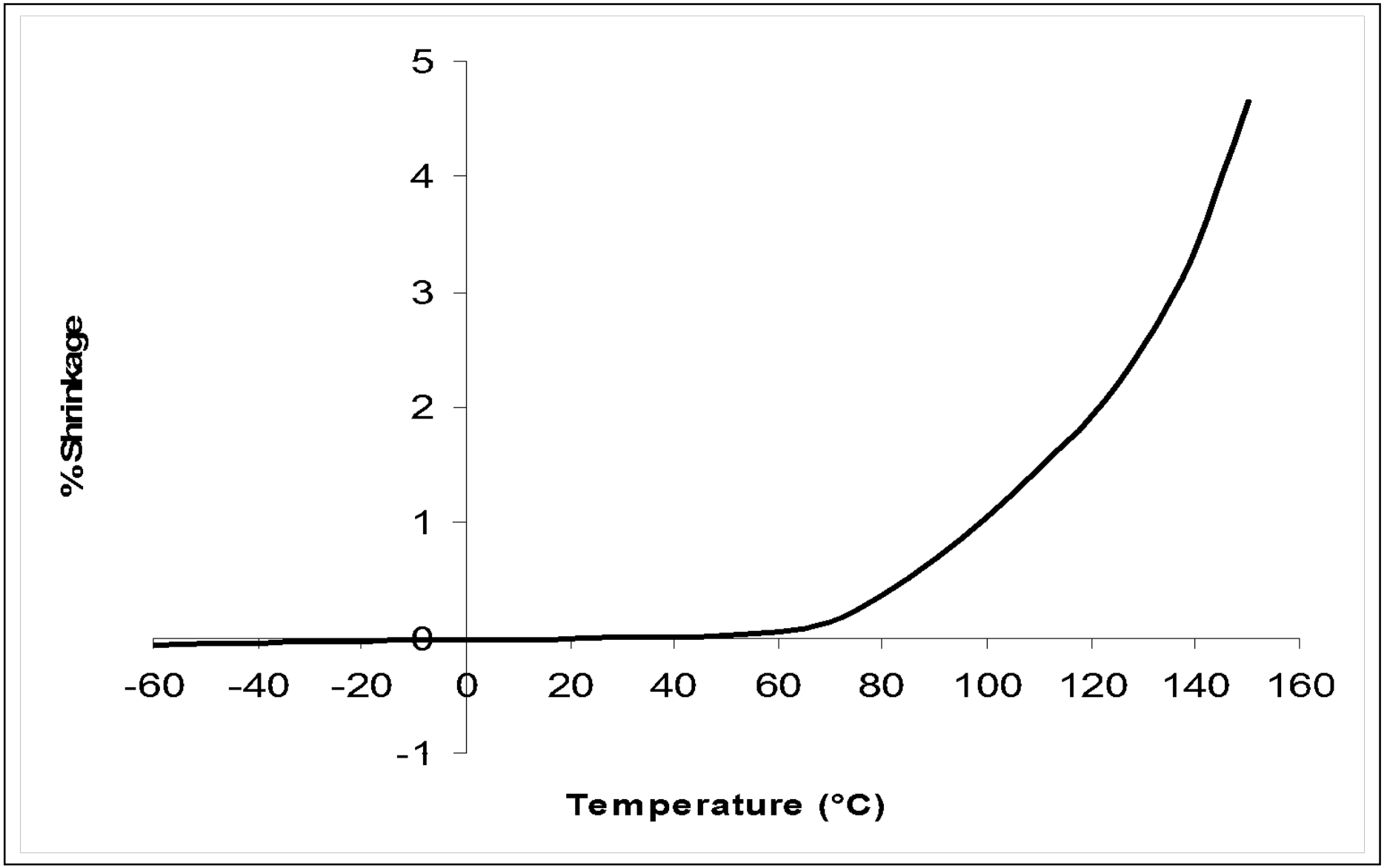




Sonic Velocity (m/s)



Thermal Shrinkage - TMA



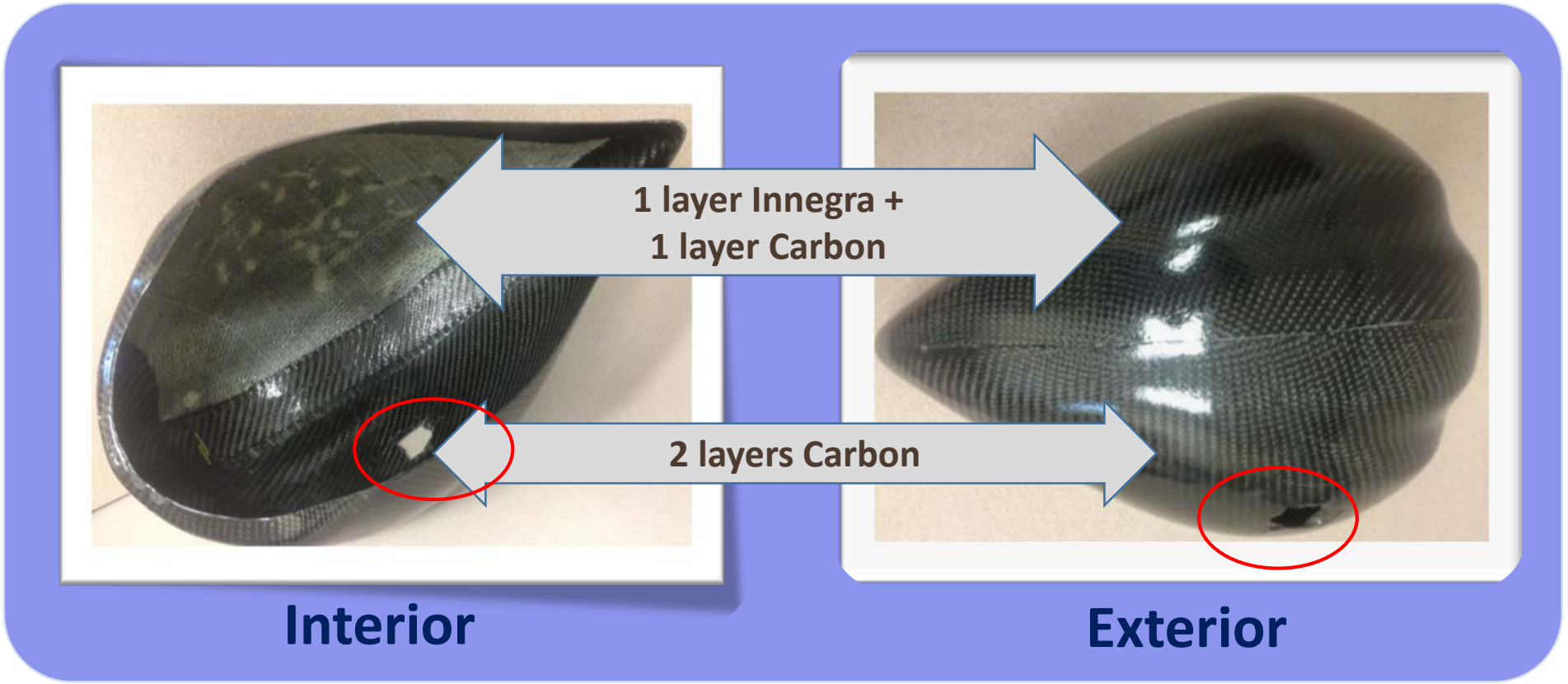
Benefits

Benefits of Using Innegra™ Fiber

- Biologically Stable
- Chemically Stable
- Cost Effective
- Ductile
- Extends Part Life
- High Sonic Velocity
- Tear Resistant
- Tough
- Washable
- Moldable
- Hydrolytically Stable
- Lightweight
- Low Creep
- Recyclable
- Low Temperature Stability
- Moisture Resistant
- Vibration Damping
- Excellent Dielectric Properties

INNEGRA™
High Performance Fiber

Impact Properties



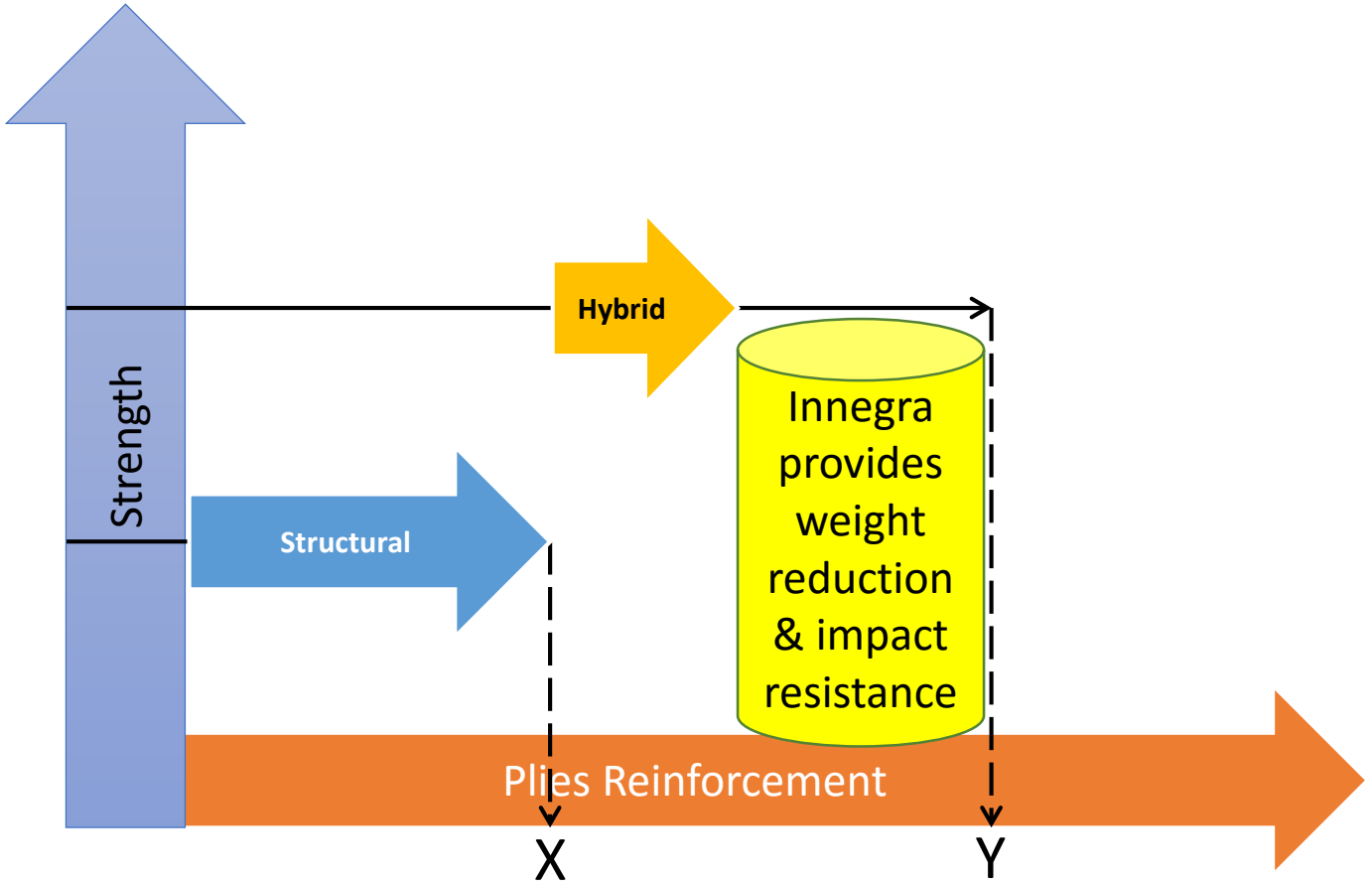
Innegra adds impact resistance

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

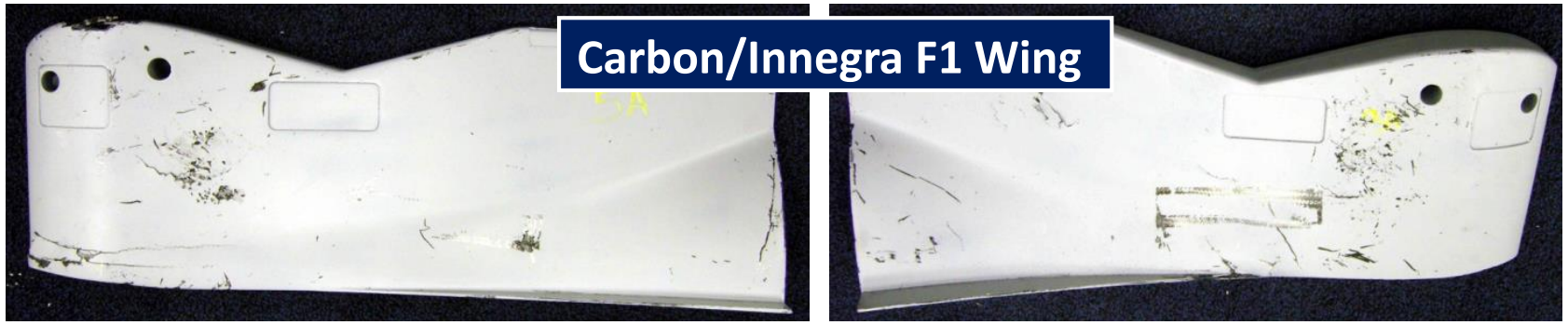
INNEGRA™ High Performance Fiber

Innegra™ Demonstration Video

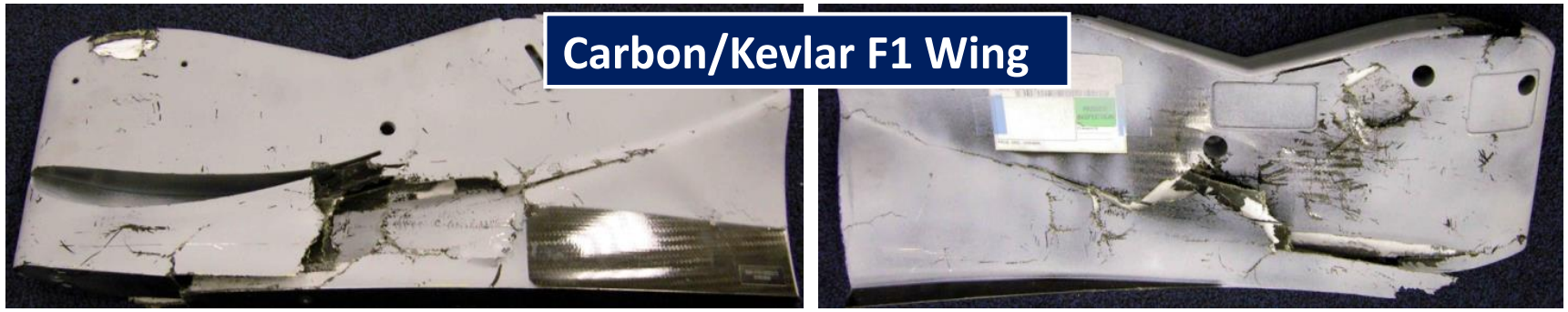
Reducing the Cost of Over-Engineering



X = structural requirement
Y = required to achieve desired impact strength
Y – X = effective over-engineering of structure



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



"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

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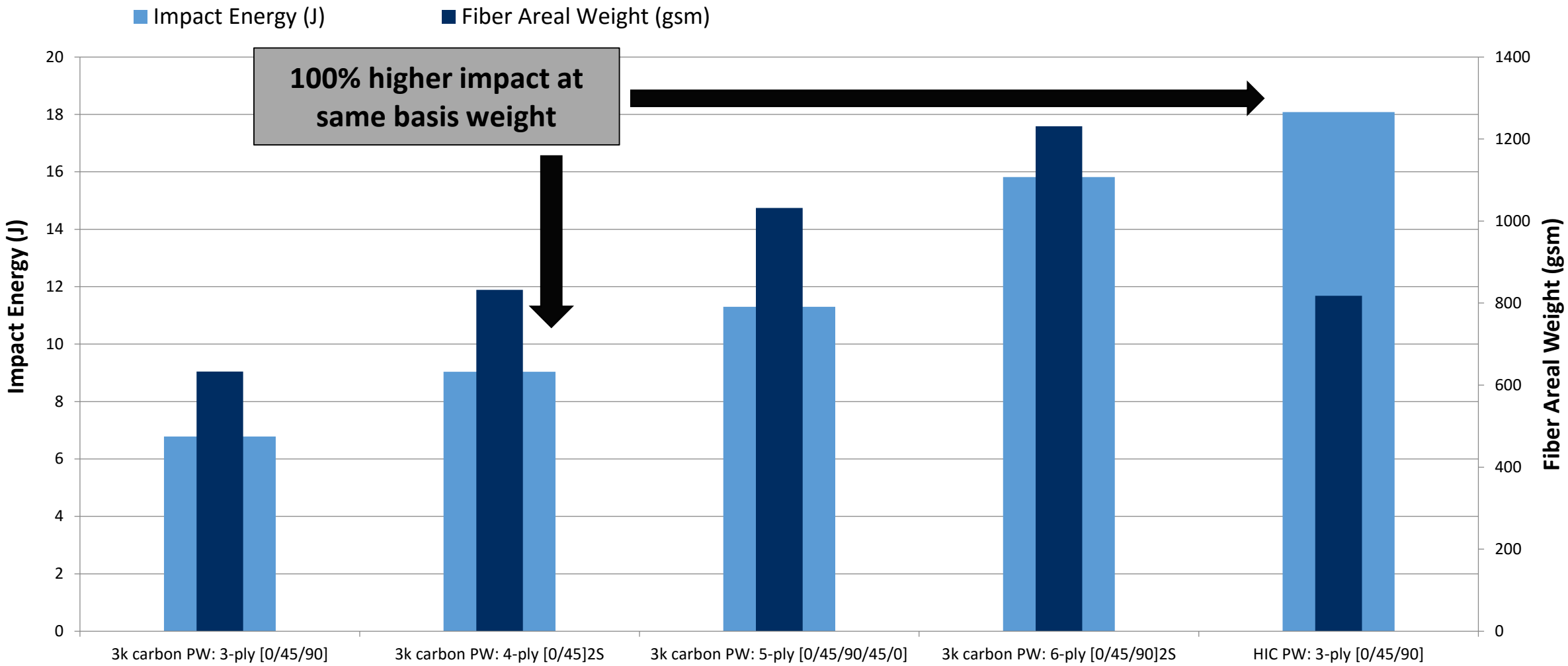
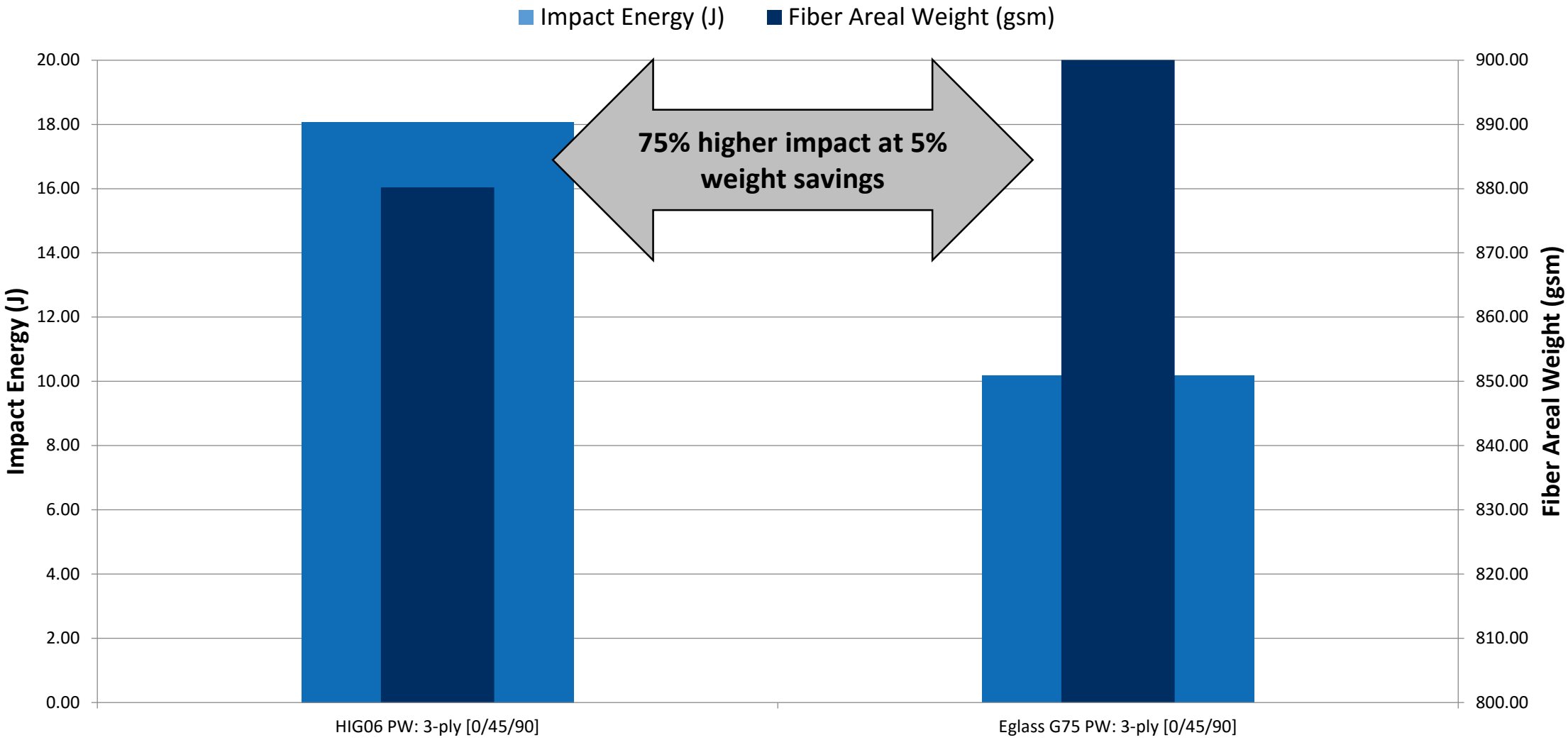
Impact Energy Absorption- Carbon



100% Carbon - Controls

Innegra™ H Fiber

Impact Energy Absorption - Glass



Hybrid Yarn

100% Glass Control

Working with Innegra™ Fiber

- Social fiber
- 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%
- Volume & weight ratios
- Will remain white
- Will add ductility

INNEGRA™
High Performance Fiber

INNEGRA TECHNOLOGIES™

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