Plant Derived Fiber for Reinforced Plastic Composites

by

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Acknowledgments

- ***The following organizations played a key role in the commercialization of Emc^2's technology involving Advanced Natural Fiber Composites – ANFC***

- ***State of Ohio Third Frontier Program – Wright Project***
- ***The Ohio State University - Research Foundation***
- ***The Ohio Soybean Council (OSC)***
- ***OSU - Ohio BioProducts Innovation Center***
- ***OSU - Ohio Agricultural R&D Center (Wooster)***
- ***OSU – College of Engineering***
- ***OSU – Food Agricultural & Biological Engineering***

Overview

- ***Emc^2 developed a proprietary technology for manufacturing plant derived Advanced Natural Fiber Composite (ANFC) compounded thermoplastic pellets for various applications and market areas including injection molded, compression molded, and extruded products***

- ***With support from OTF, OSU, and OSC the technology has been significantly expanded to a wide range of plant derived reinforcements – soy hulls, wheat straw, oat hulls, coconut shell, miscanthus, etc.***

Opportunities for Bio-based Materials

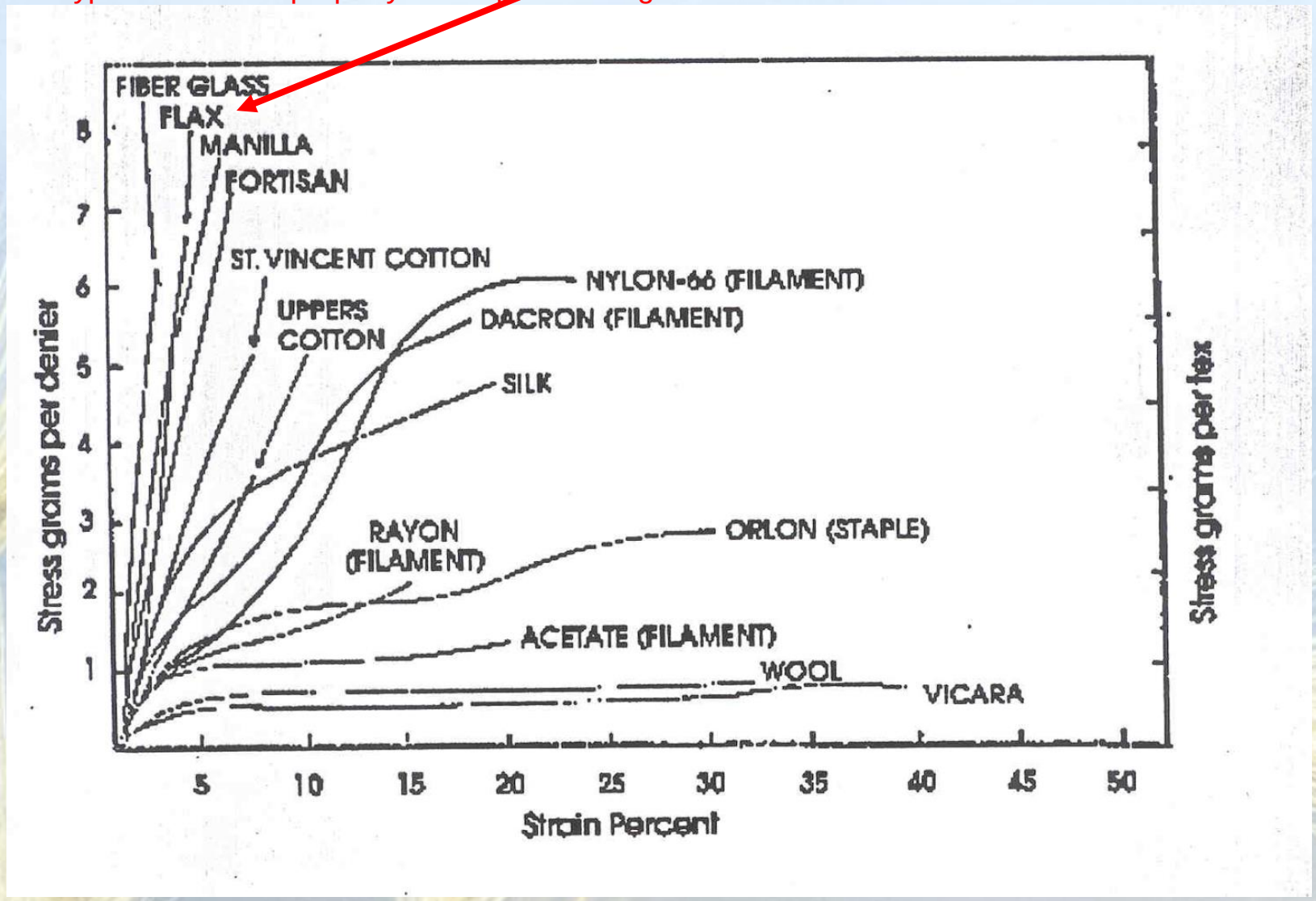
- ***Technologies available from two mature industries – Agriculture and Polymers***
- ***Opportunities for Innovation in Combining Manufacturing Processes***
- ***Development of Novel Formulations with Unique Properties***

Driving Forces for ANFC

- ***Weight Reduction (more parts per unit weight)***
- ***Renewable Resource***
- ***Recycling/Disposal***
- ***Replace conventional reinforcements in some Applications***
- ***Less abrasion to equipment***
- ***Design Flexibility/Modularity***

Motivation for Original Technology - Bast Fiber

Typical bast fiber property is comparable to glass fibers



ANFC Typical Performance Data Sheet

TYPICAL PROPERTIES OF ADVANCED NATURAL FIBER COMPOSITES (PP + Bast Fiber)				
PROPERTY	**ASTM TEST METHOD**	**UNITS**	**Values FOR PP**	**Value Range FOR ANFC**
PHYSICAL				
Fiber Type				Bast Fibers
Reinforcement Content (by weight)		%	0	35 - 40
Melt Flow Index	D1238	g/10min	12	2 - 4
Specific Gravity/ Density	D792	g/cm3	0.9	1.01 - 1.05
Shrinkage - Flow Direction 1/8"	D955	in/in	0.025	0.004 - 0.006
Rockwell Hardness	D785		R80	D81 - D82
Water Absorption, 24 hrs.	D570	%	0.03	0.7 - 0.8
MECHANICAL				
Tensile Strength	**D638**	**psi**	**3900**	**6,500 - 7,200**
Tensile Modulus	D638	ksi	190	650 - 750
Tensile Elongation	D638	%	>10	3.0 - 4.0
Flexural Strength	D790	psi	6000	10,500 - 11,500
Flexural Modulus	**D790**	**ksi**	**180**	**550 - 700**
Izod Impact (notched)	D256	ft-lb/in	0.6	0.43 - 0.47
Izod Impact (unnotched)	D4812	ft-lb/in		3.0 - 3.3
THERMAL				
Coefficient of Expansion	D696	10^-5 in/in/F	5	1.7 - 1.9
Deflection Temp. Under Load @ 264 psi	**D648**	**deg F**	**130**	**250 - 275**

ANFC can achieve 20% glass reinforced PP properties

ANFC Pilot Plant Capabilities

- ***ANFC Pilot Plant installed in Wooster OH – annual capacity of 6M lbs/year***

- ***Bio-Fibers: jute, kenaf, hemp, soy hulls, coconut fiber, wheat straw, oat hulls, etc.***

- ***Resins: PP, PE (extrusion & injection molding); ABS, PLA, etc.***

Sample Parts

Automotive

Furniture

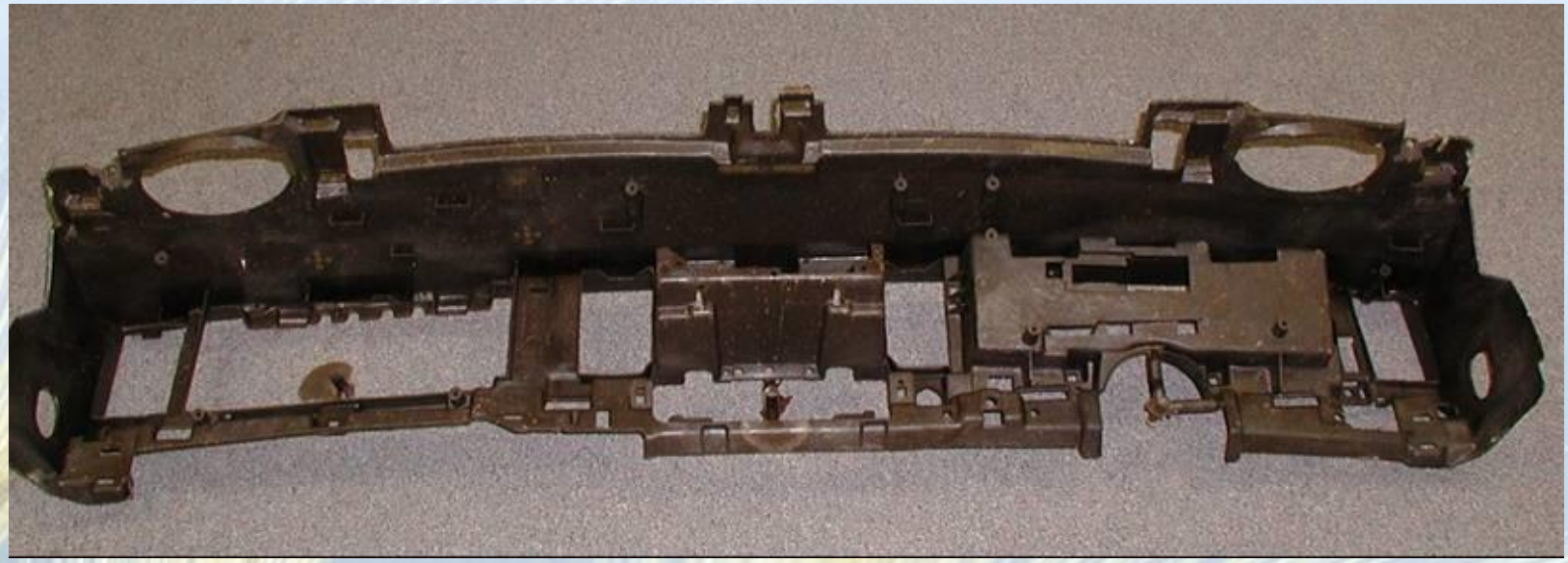
ANFC Pellets

Consumer

Building & Construction

Commercialization Trials

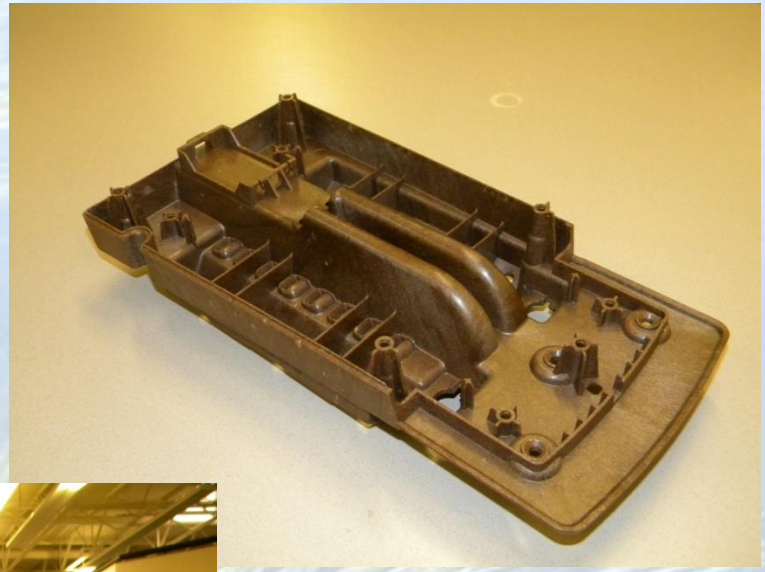
Commercialization Trials (automotive)



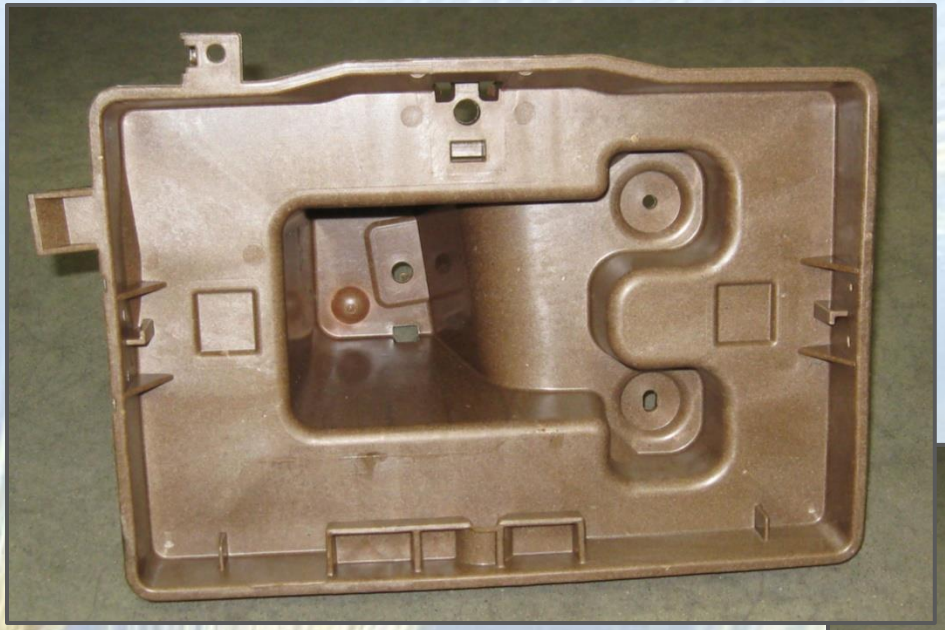
Single shot (58” x12” x12”) made on existing equipment with no change in cycle time.

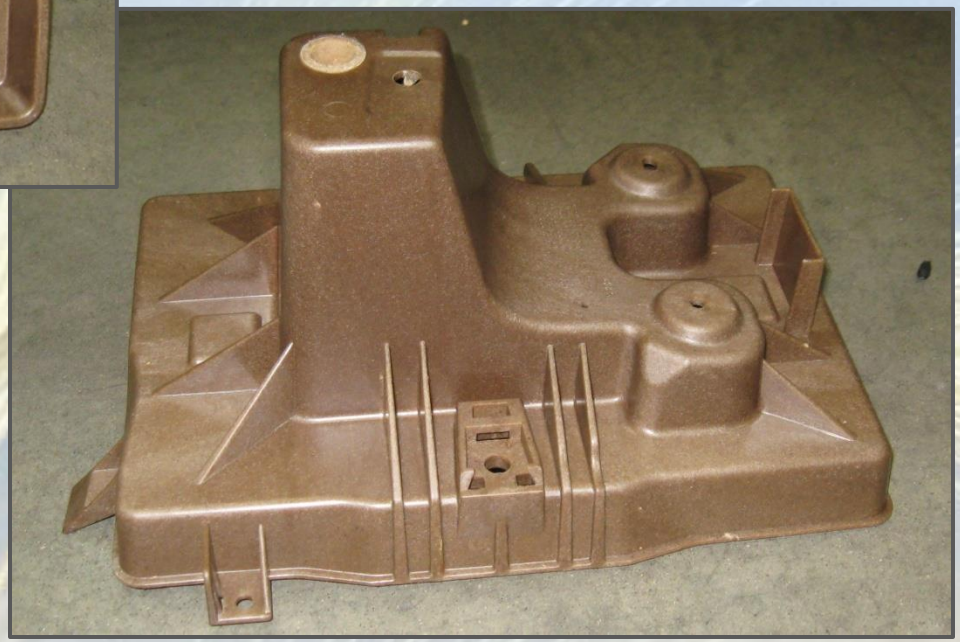
Commercialization Trials (automotive)

Commercialization Trials (automotive arm rest)



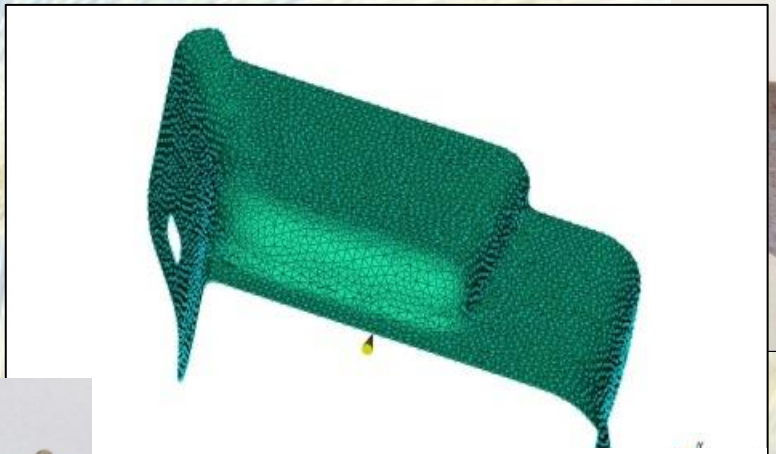
Commercialization Trials (automotive – battery tray)





Commercialization Trials (automotive part using soy hulls)

Injection Molded Part



Simulation used to design part

ANFC Pellets

Commercialization Trials (dunnage)

Commercialization Trials (building & construction)

Commercialization Trials (building & construction)

Commercialization Trials (building & construction)

Commercialization Trials (outdoor applications)

Commercialization Trials
Product Ready for Shipment…

Commercialization Partner

- ***GDC Inc. Goshen, IN –Strategic Partner marketing ANFC material and products under the trade name DeepGreen Composites***

Questions ???