

Development of Injection Moldable Composites Utilizing Annually Renewable Fibers



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Ellen C. Lee, *Ford Motor Company*

Paul A. Hardy, *A. Schulman, Inc.*

Prof. Leonardo Simon, *Univ. of Waterloo*

Presentation Outline

- Growing commitment for the use of renewable materials in automotive applications
- Development of BioFiller composite
 - BioFiller type, loading level, OEM specifications
- BioFiller product and application selection
- Trials and testing
- Next steps



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Ford's Commitment

*"Ford is committed to offering customers affordable, **environmentally friendly technologies** in vehicles they really want. We are focused on providing solutions that can be used not for hundreds or thousands of cars, but for millions of cars because that is how Ford can truly make a difference."*



-Alan Mulally
President & CEO
Ford Motor Company



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Many Renewable Options

- ❑ BioFiller types include agricultural crops such as:
 - ❑ Hemp, Coconut fiber, Sisal, Switch Grass, Flax, Soy, Wood, Canola, Wheat Straw
- ❑ Important considerations for BioFiller selection:
 - ❑ Some of these compete with the food chain
 - ❑ Several of these have higher costs associated to the material than typical mineral fillers
 - ❑ Higher costs can be attributed to the material, harvesting process, production process, yields, etc.
 - ❑ Some provide reinforcement while others merely serve as fillers



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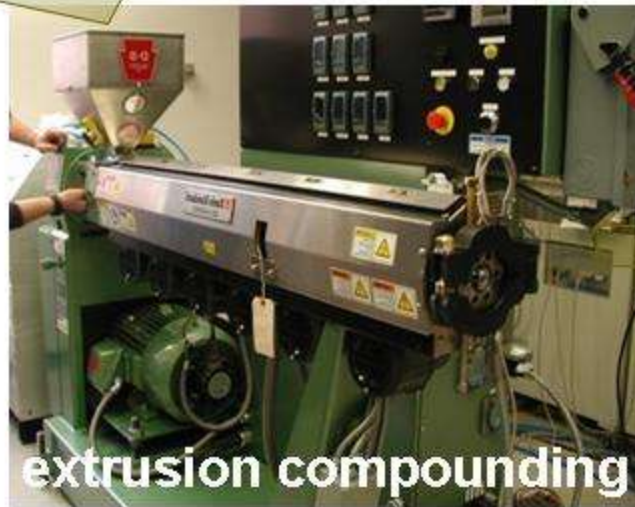


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BioFiller Composite Process



+ PP




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Comparing BioFiller Properties

Agricultural BioFiller Testing				
PHYSICAL PROPERTY	UNIT	WS Fiber	Wood Powder	Canola Flour
Melt Flow Rate (230°C / 2.16kg)	g/10 min.	6.1	7.3	14.1
Mineral Filler	%	30	30	30
Density	g/cm	1.02	1.035	1.00
Tensile Strength @ Yield	MPa	25.6	22	14.8
Flexural Modulus	MPa	3138	2638	1600
Notched Izod Impact @ 23 ± 2 °C	kJ/m ²	5.5	6.3	3.9
Notched Izod Impact @ -40 ± 2 °C	kJ/m ²	2.6	2.9	2.1



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BioFiller versus Talc

Physical Property	Test Method	Units	20% Talc	20% BioFiller	30% Talc	30% BioFiller	40% Talc	40% BioFiller
Density	ISO 1183	g/cm ³	1.01	0.96	1.07	0.99	1.16	1.03
Melt Flow	ISO 1133	g/10min	23.2	15.0	21.0	12.4	8.4	4.5
Flexural Modulus	ISO 178	MPa	2107	1962	2602	2525	3265	2979
Tensile @ Break	ISO 527	MPa	25.5	23.2	25.7	25	26.4	25.7
Elongation@Break	ISO 527	%	31	3.4	20.7	2.0	10.5	2.0
Notched Izod, RT	ISO 180	kJ/m	4.2	4.6	3.6	3.8	2.7	3.8
Notched Izod, -40	ISO 180	kJ/m	2.2	2.5	2.1	2.1	2.2	2.3
HDT, 0.45 MPa	ISO 75	C	101	114	107	133	116	138
HDT, 1.8 MPa	ISO 75	C	57.6	60.5	60	74.5	64.5	82.2
Mold Shrink, 48 hrs	5" x 7"	%	0.94	0.75	0.86	0.56	0.76	0.52



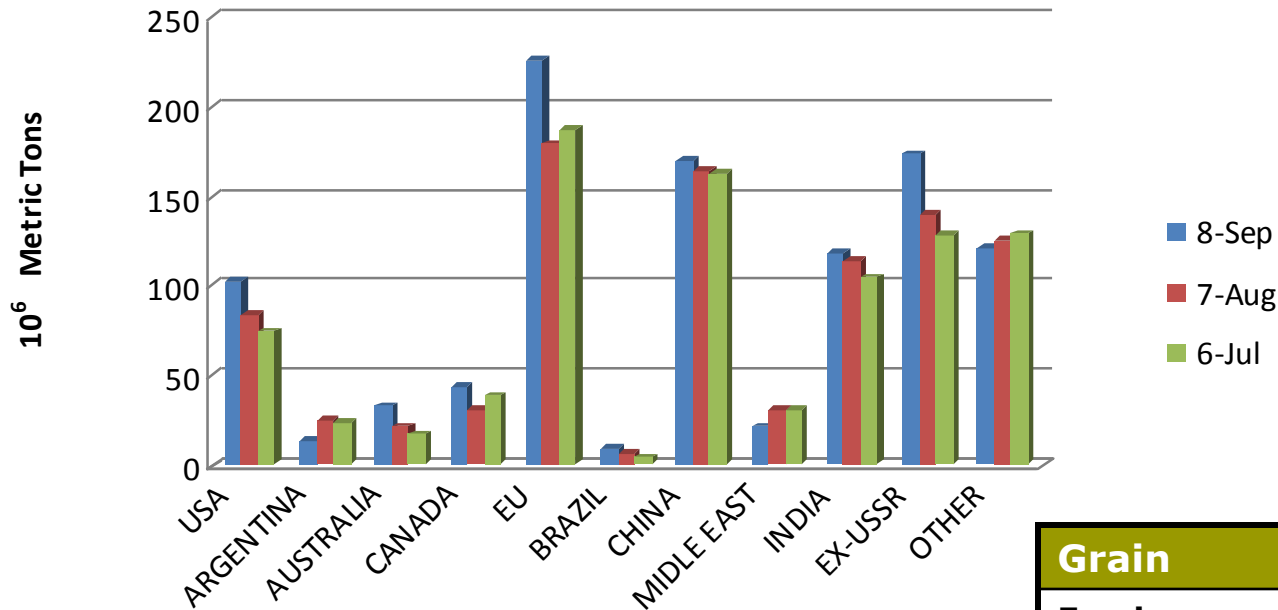
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Wheat Straw Global Availability

Stem Biomass from Wheat



Grain	Straw
Food	Bedding
Animal Feed	Mushroom Compost
Other uses	Plastic Composites



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Wheat Straw PP Composite Evaluations

□ Compounded wheat straw with PP

- Joint project initiated through Biocar
 - Ford, A. Schulman, Omtec, University of Waterloo
- Performed multiple compounding and molding trials
- Produced and evaluated samples for material specification testing and appearance evaluations
- Due to promising properties there is strong interest within Ford for applications in:
 - Interiors
 - Interior Design
 - Exterior/ Underbody
 - Underhood



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Near Term Applications for Wheat Straw- PP Composites



Fuel Tank Shield



Battery Tray

Injection Molded Opportunities

Interior:

- ❑ seat side shields
- ❑ center consoles/ hard trim
- ❑ appliqués/ bezels/ substrate

Exterior/Underbody:

- ❑ splash shield
- ❑ fuel tank shield
- ❑ leaf or cowl screens

Underhood:

- ❑ battery tray
- ❑ air cleaner housing
- ❑ beauty covers

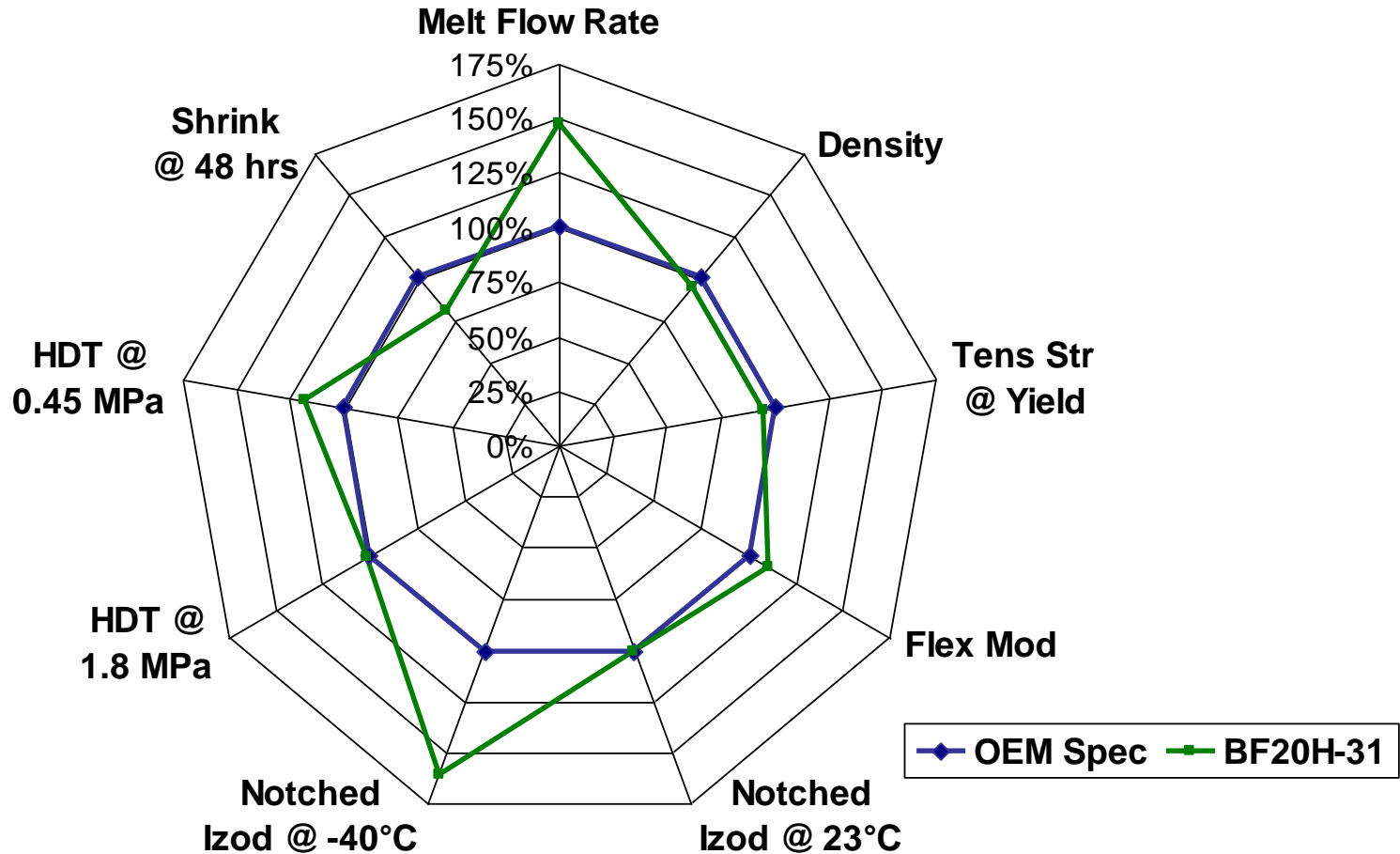


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OEM Material Specification vs. BF20H-31

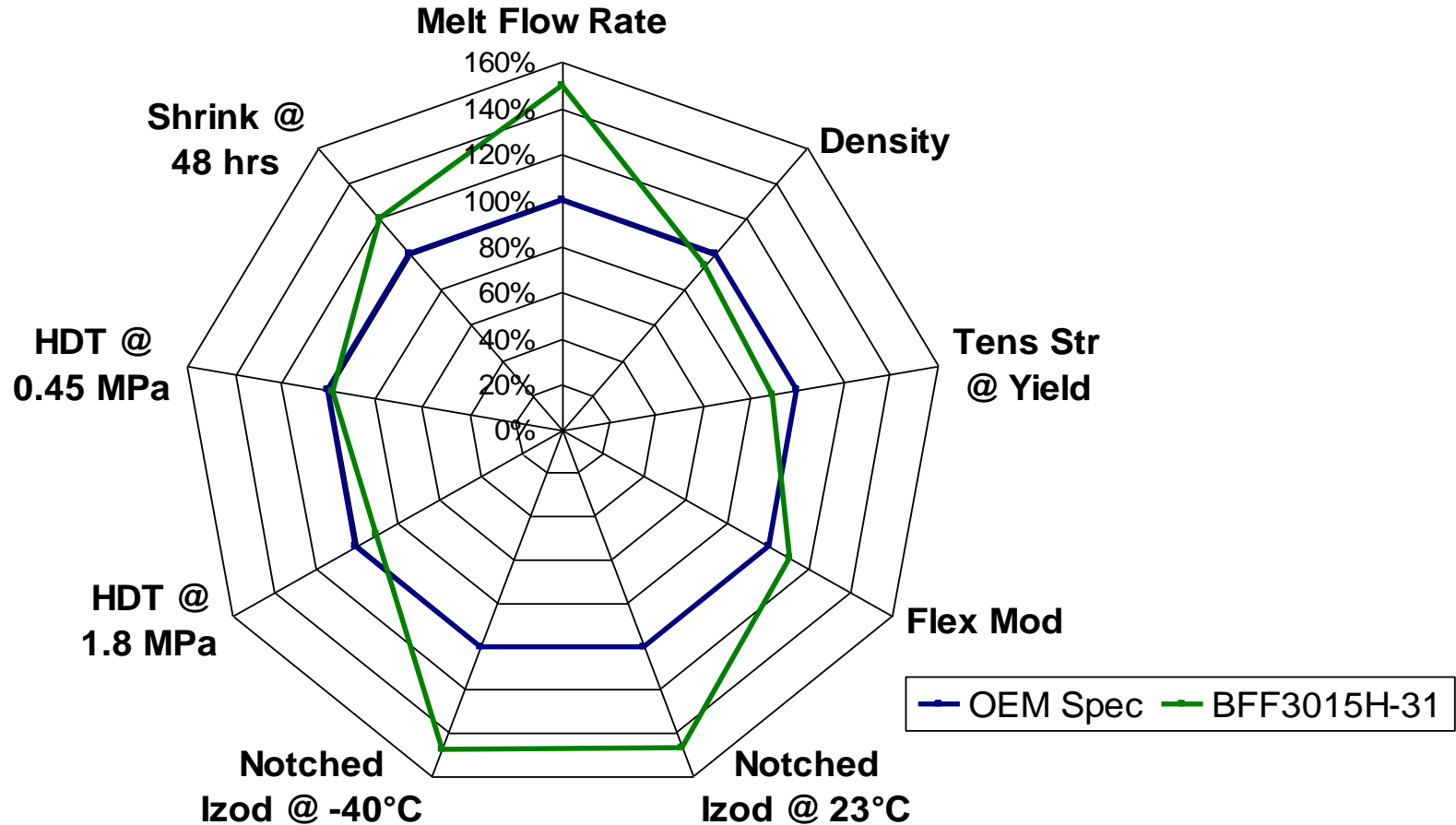


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OEM Material Specification vs. BFF3015H-31



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Application Testing Completed

- ❑ Heat Aging at 120°C for 1000 hours – pass (Rating1)
- ❑ Interior Xenon Weathering – pass (Rating 1)
- ❑ Exterior Xenon Weathering – in process, 95% complete, (Rating 1)
- ❑ Flammability, UL 94 HB & ISO 3795 – pass (17/41)
- ❑ Water Absorption – ASTM D570 – pass (0.76%)
- ❑ Gas Fade (168 hours@ 60°C) – pass ($\Delta E1.34$)
- ❑ Fogging @ 95°C – pass (93)
- ❑ Odor – FTLM BO-131-01 – pass (Rating 2)
- ❑ 5 Pass Regrind Study – in process after 2 passes



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Consistent BioFiller Product Performance

- ❑ A well-defined process established to remove contaminants and control fiber length and aspect ratio
- ❑ Fiber is classified to a controlled length, smaller fibers separated, and a percentage of longer fibers reprocessed
- ❑ Testing in process to compare Canadian BioFiller with the same type crop that is grown in other regions of the world
- ❑ Compounded on twin screw extruders to provide the best consistent quality
- ❑ Proprietary formulations and compounding parameters developed that address special needs of BioFiller materials
- ❑ Over 30 lots produced to validate consistency and property performance



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Current Status and Next Steps

- ❑ Several part trials have been completed on applications including:
 - Underhood Housings
 - Cargo Area
 - Interior Storage Bins
- ❑ BioFiller product easily molded as a drop-in using typical molding conditions
- ❑ Significant weight reductions achieved at competitive economics
- ❑ DV component level testing in process
- ❑ Undergoing evaluation for color and trim approvals
- ❑ Multi-lot product approval testing



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Future Opportunities for BioFiller Materials

- ❑ Marketing the use of “green materials” by emphasizing use of natural products in key interior and appearance locations
- ❑ Molded in color applications highlighting the special effect produced from the BioFiller aesthetics
- ❑ Opportunity for over molded applications



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