Viability and Future of Certain Biocomposites

Chad A. Ulven, PhD
Department of Mechanical Engineering
North Dakota State University
Fargo, ND

Chief Technology Officer - c2renew Inc.
Fargo, ND

New Opportunities in Sustainable Materials – September 23rd 2020

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What is Possible for Natural Fibers and Biocomposites?









YES!!!

Biobased Plastics?

Epoxy or Acrylic type thermoset plastics from epoxidizing vegetable oils?

Cellulose Acetate type thermoplastic by deconstructing cellulose from different sources?

Polylactic Acid type thermoplastics by cellulose hydrolysis?

YES!!!

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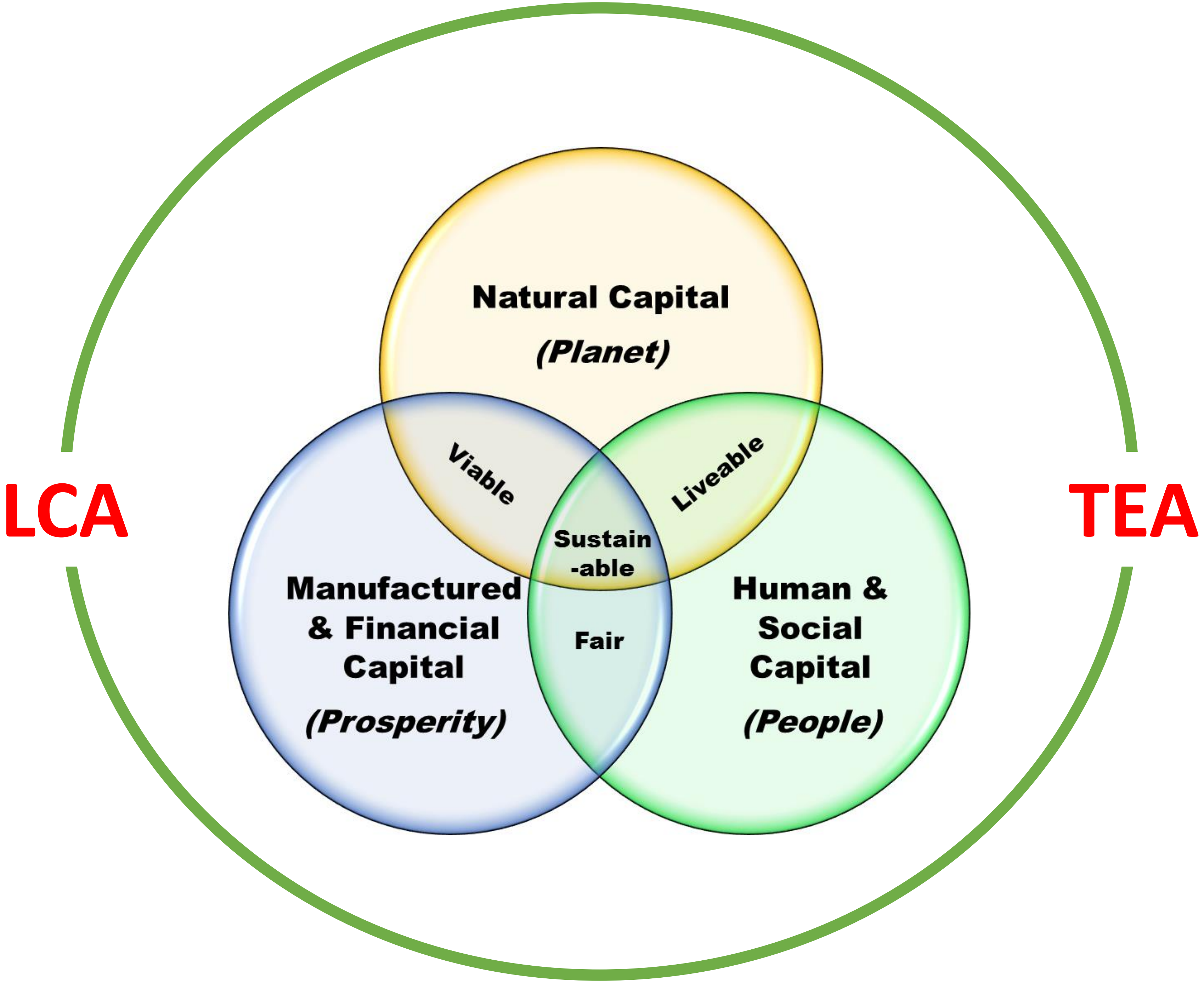
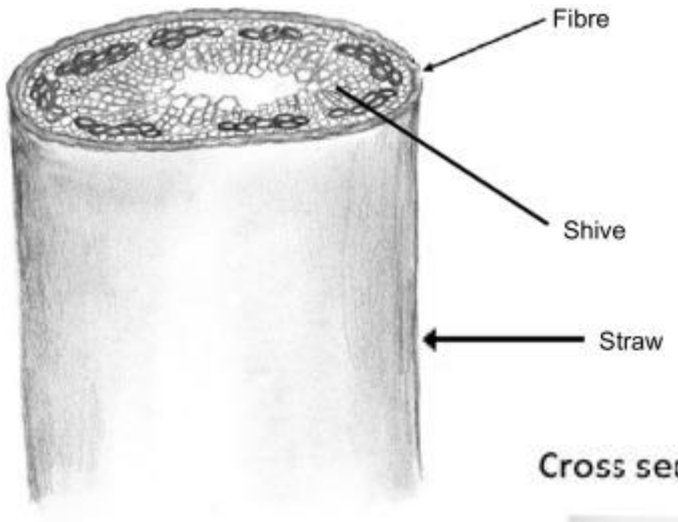
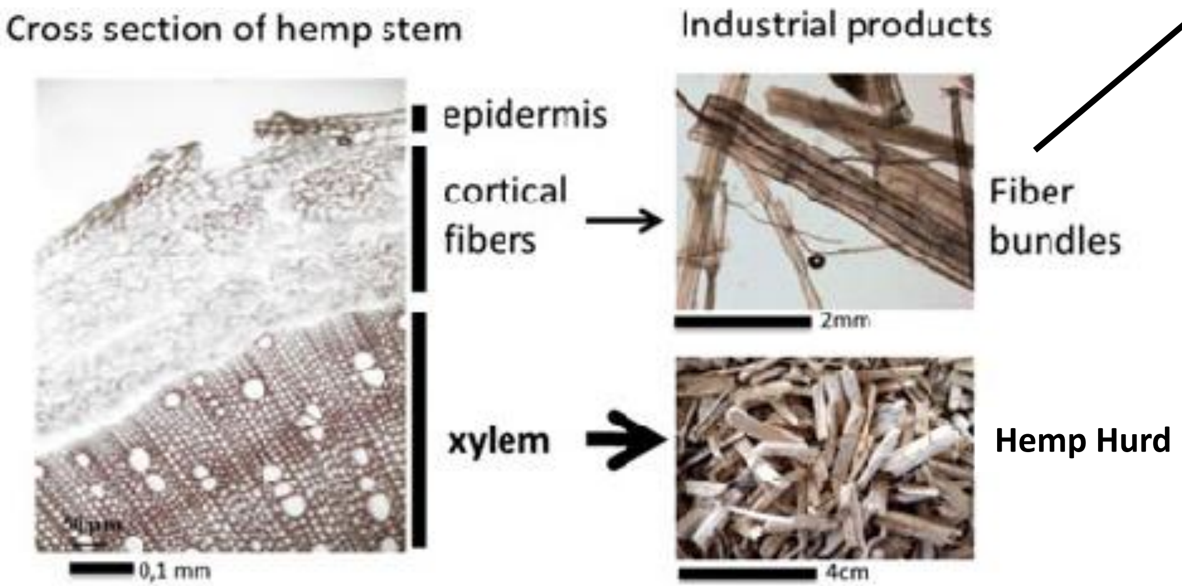
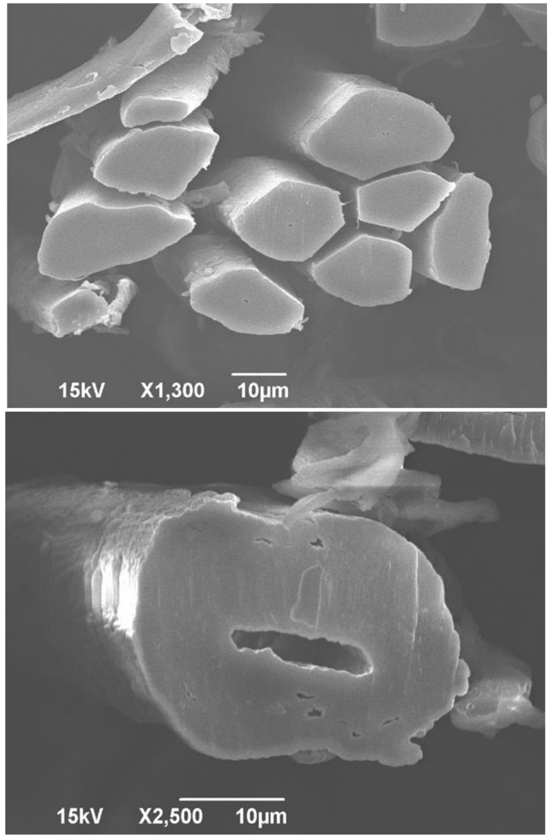

LCA
TEA
Natural Capital
(Planet)
Viable
Liveable
Sustain
-able
Manufactured
& Financial
Capital
(Prosperity)
Fair
Human &
Social
Capital
(People)

Breakdown of Bast Straw



Decortication





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Natural Fiber Properties

Fiber Species*	Tensile Strength (MPa)	Stiffness/Young's Modulus (GPa)	Density (g/cm^3)
Willow bast fiber	307.6 ± 130.1	16.9 ± 8.4	1.19 ± 0.2
Abaca**	400	12	1.5
Alfa**	131 - 220	4 - 6	1.5 - 1.6
Bagasse*	290	17	1.25
Bamboo*	140 - 230	1 - 17	0.6 - 1.1
Coir**	188 - 308	18 - 25	1.2
Cotton**	287 - 800	5.5 - 13	3.7 - 8.4
Flax**	345 - 1830	27 - 80	1.5
Hemp**	550 - 1110	58 - 70	1.5
Jute**	393 - 800	10 - 55	1.3 - 1.5
Kenaf*	930	53	-
Ramie*	560	24.5	1.5
Sisal**	507 - 855	9.4 - 28	1.3 - 1.5
Napier grass***	106	39 - 47	0.358

Constituents of Bast Fibers

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Table 8. Characteristics of Long Bast Fibers Produced from Hemp, Jute, Flax, and Kenaf

Type	Fiber chemical content						Tensile strength (mm)	Moisture content %	Yield (tonne/ hectare)	Retting methods	Quality	references
	Fiber Length (mm)	Fiber diameter microns	Lignin %	Cellulose %	pectin	Hemi cellu-lose %						
Hemp	15-55	17-22.8	5-3	70-92	0.9	18-22	310-750	<15	8-18	Chemical retting	Fair	5,7,10,14,15,16,17,18, 19,20,21
Jute	2-5	15.9-20.7	5-13	51-84	0.2	12-20	200-450	23	2-4	Dew retting	Good	5,7,8,9
Flax	9-70	5-38	14-19	60-81	0.9	2.3	345-1100	10-12	1.4-2.5	Enzymatic retting	Fair	2,5,7,9,10, 11,12,13
Kenaf	2.6-4	17-21.9	15-19	44-57	2	21	295-1191	10-20	2-4	Water retting	Good	1,2,3,4,5,6

Source: [1] Misra (1987), [2] Mohanty et al. (2001), [3] Rowell and Han (2000),[4] Anon. (2001), [5] Perry (1975), [6] Carr et al. (2005), [7] Skorski (1963), [8] Gassan and Bleddzki (2001), [9] Rowell and Stout (1998), [10] Harders and Steinhauser (1974), [11] Alann André. (200)6, [12] Rowell and Han (2000), [13] Biogiotti and Kenny (2004), [14] Kozlowski (2000), [15] Joseph (2002), [16] Meier and Mediavilla (1998), [17] Mwaikambo and Ansell (2006), [18] Peston (1963), [19] Hughes (2000, 1997), [20] Ronalli (1999), and [21] Mwaikambo (2002)

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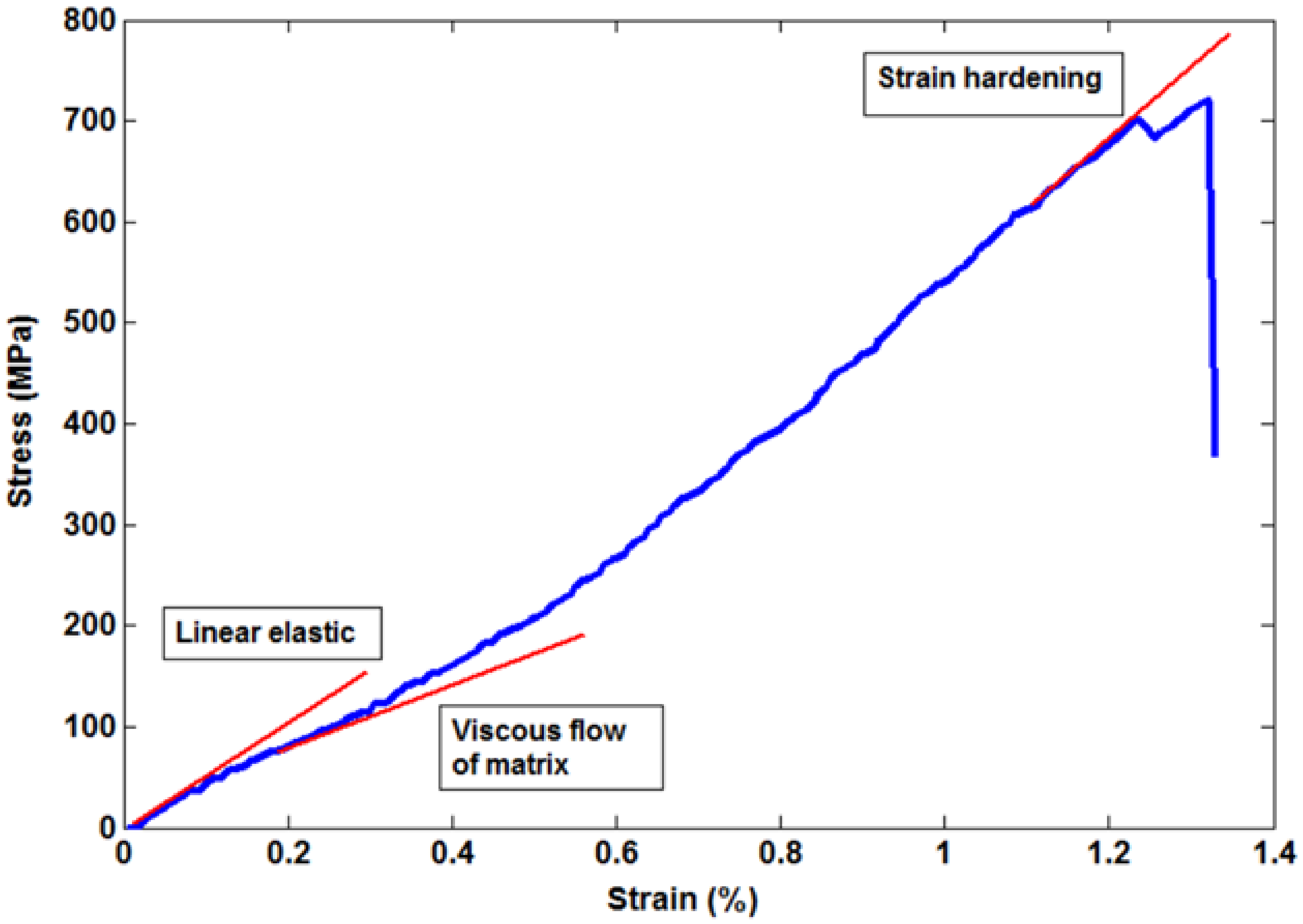
Understanding Natural Fiber Stress-Strain Behavior



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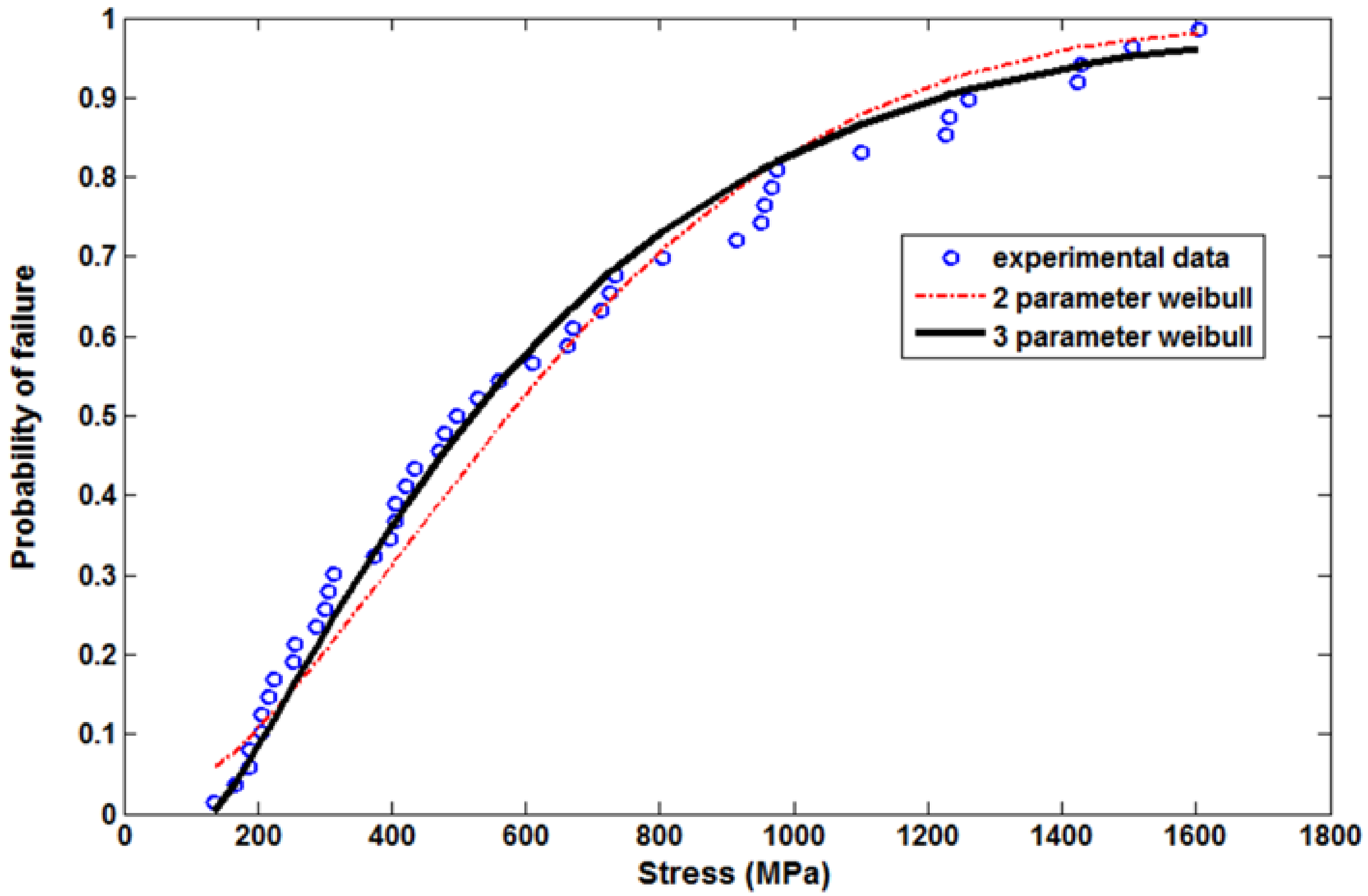
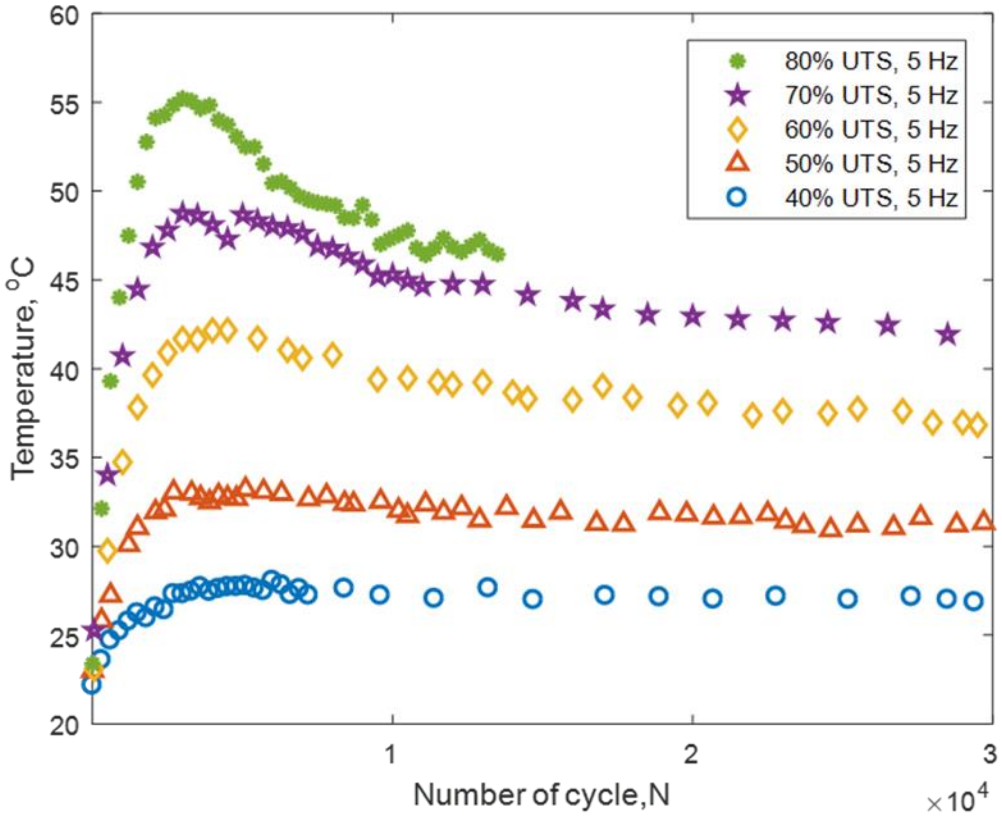
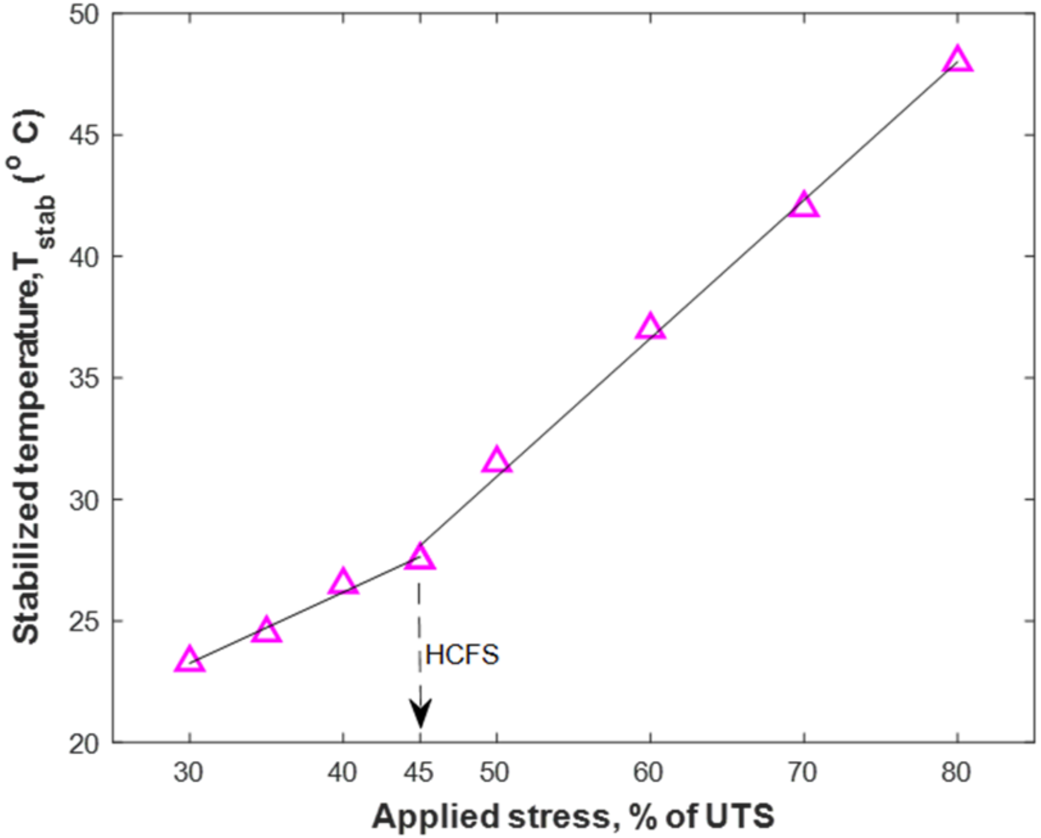
Statistical Modeling Approaches



Fatigue Testing and Modeling





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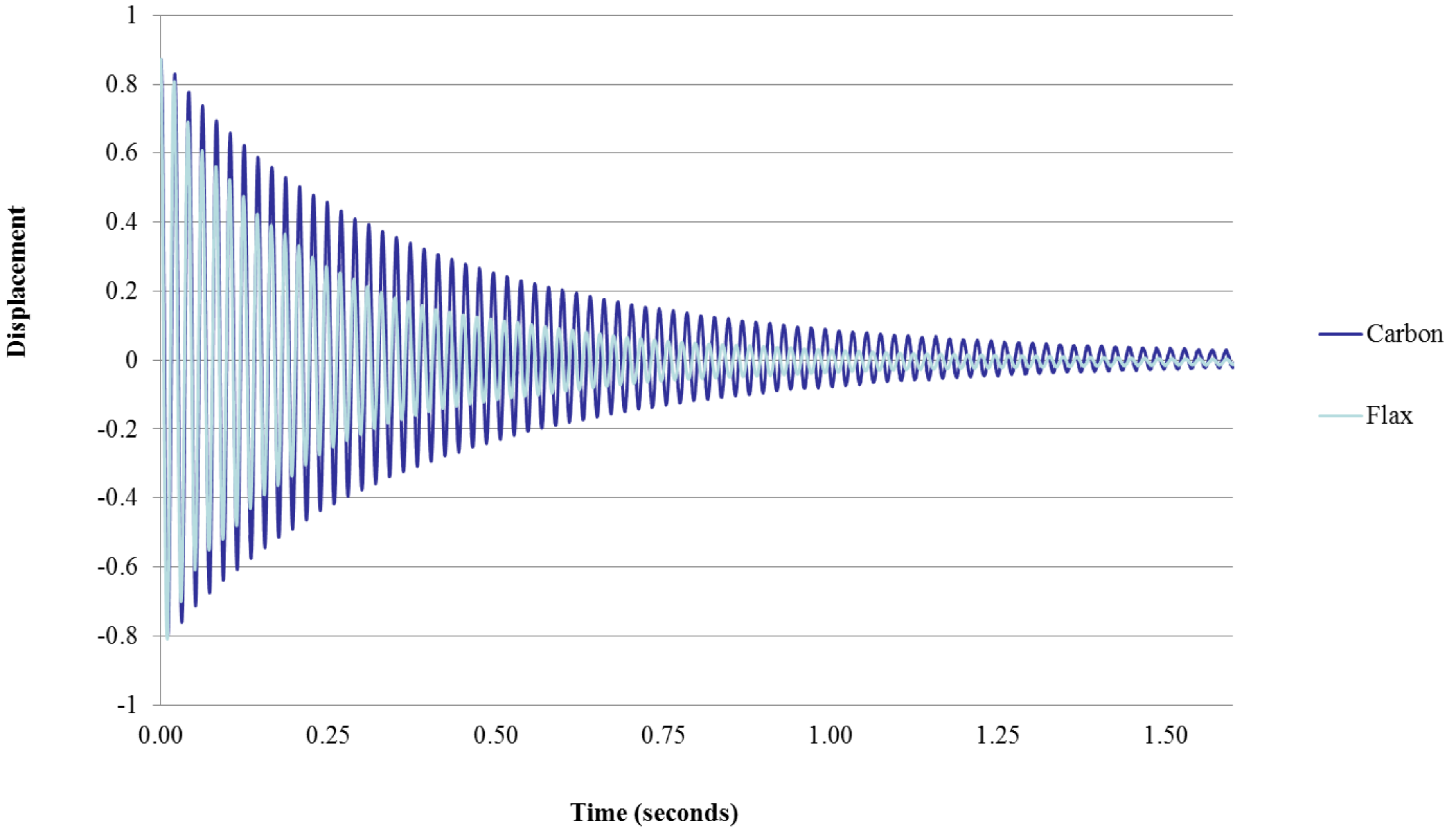
Vibration Damping Characteristics



Biocomposite & Supply Chain Challenges

- Lack of standards for natural fibers and their biocomposites
- Lack of defining and understanding compostable vs. biodegradable
- Lack in understanding types of decortication technology to use and where
- Lack in understanding where to locate decortication facilities
- Lack in understanding quality, procurement, and transportation of straw

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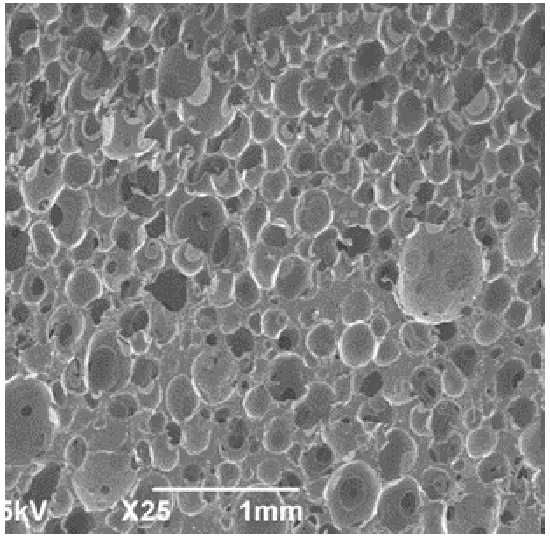
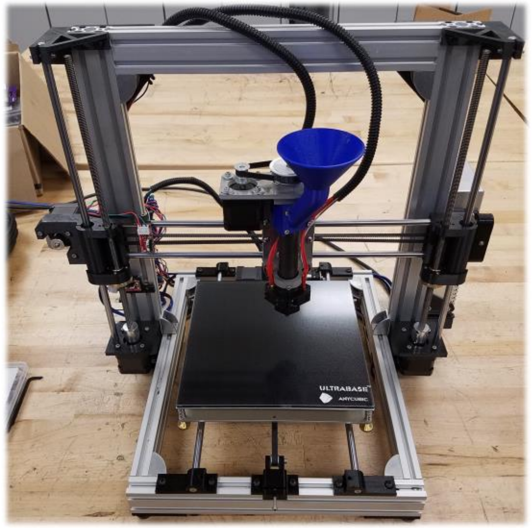
Biocomposite Opportunities

- Continued fiber hybridization for structural applications
- Foams and foam composites (non-isocyanate based)
- Long fiber thermoplastics (extrusion/compression molding)
- Additive manufacturing (pellet fed large/big area)





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Thank You!