PFAS and Molded fiber: Challenges and Opportunities

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OUR CHALLENGE

PFAS-Free Molded Fiber Food Packaging

Images from Shopify, Fast Company, BrenMarco

A replacement for PFAS among molded fiber…

Is compostable

Plant or biologically sourced

Provides a barrier property

Either water or oil

Is less hazardous than PFAS

Category 1:
Alternatives *Added to* the Paper System

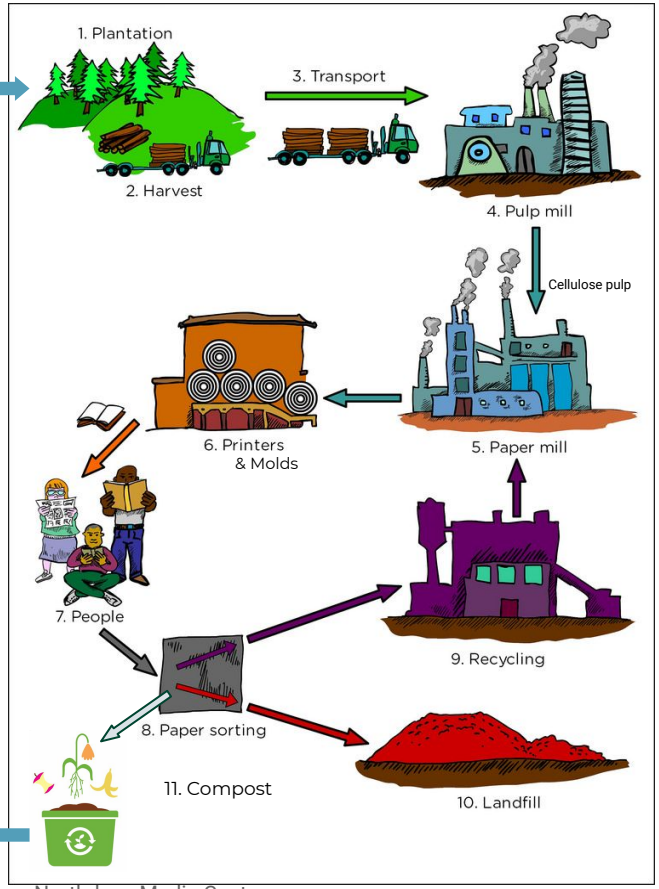
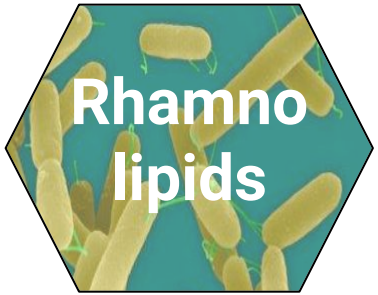
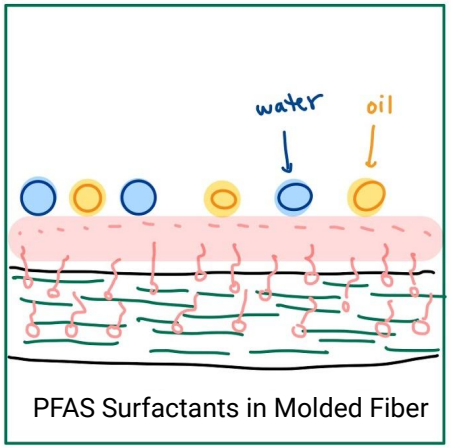


Image from Northdene Media Centre



RHAMNOLIPIDS

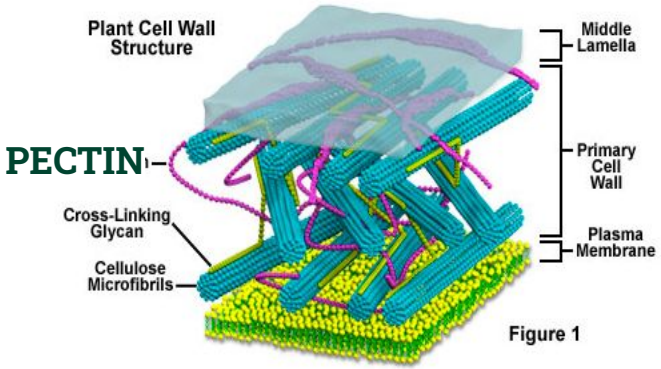


PFAS Surfactants in Molded Fiber

Source / Manufacture	Key chemical characteristics	Expected mechanism of action at wet-end	Biodegradable?
microbes, typically *Pseudomonas*	hydrophilic head and hydrophobic tails	Head groups bind to hydroxyl groups of cellulose, with hydrophobic tails extending out	Yes

Image from Dennis Kunkel Microscopy, and Kelly Chou

PECTIN

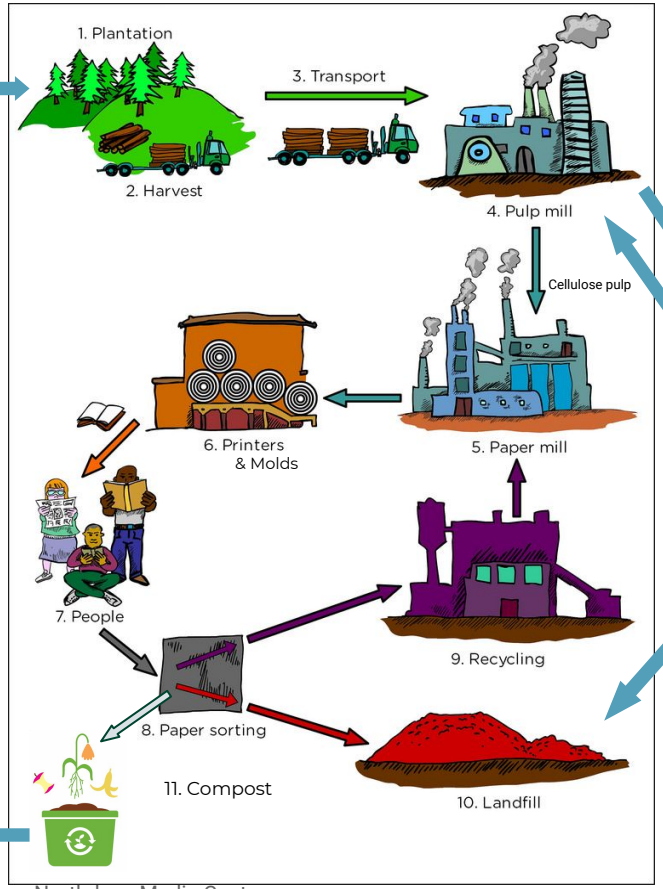


Plums contain pectin

Source / Manufacture	Key chemical characteristics	Expected mechanism of action at wet-end	Biodegradable?
Biopolymer found in ripening fruits	Reduces fiber porosity, and increase barrier properties.	Cross-linking to reduce cell porosity	Yes

Image from Molecular Expressions, Gardening Know How

Category 2:
Alternatives *Within to* the Paper System



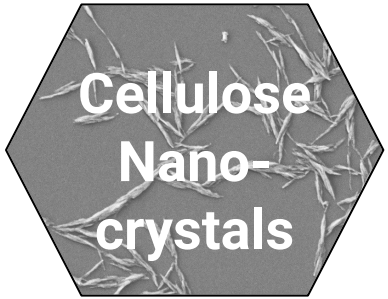
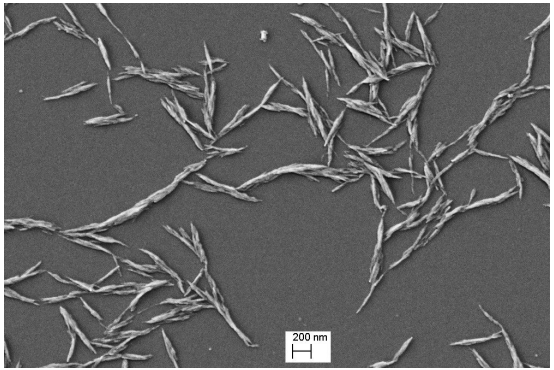
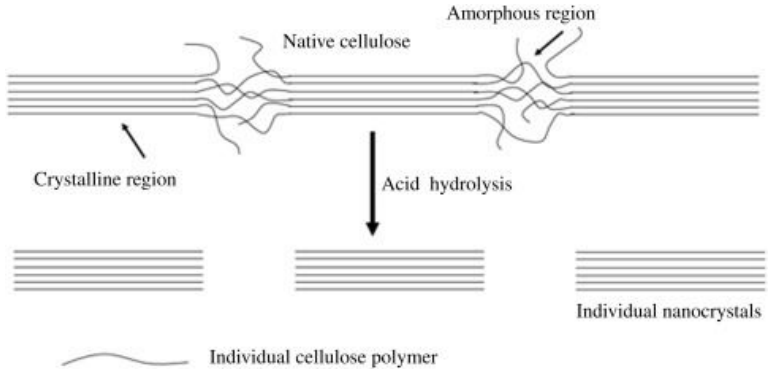


Image from Northdene Media Centre

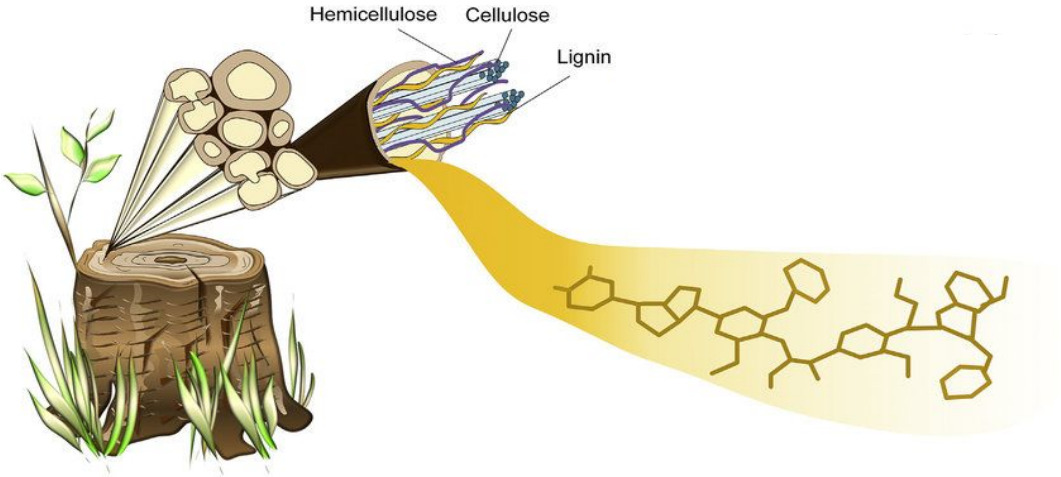
CRYSTALLINE NANOCELLULOSE





Source / Manufacture	Key chemical characteristics	Expected mechanism of action at wet-end	Biodegradable?
Recycled or newly manufactured cellulose	Improves rigidity and reduces water uptake of cellulose	Cross-linking to reduce cell porosity	yes

Image from Bhat, et al., (2017)



LIGNIN


dried lignin

Source / Manufacture	Key chemical characteristics	Expected mechanism of action at wet-end	Biodegradable?
Waste from Paper Industry (and ethanol production)	Organic polymer that improves rigidity, thermal stability	Once evenly dispersed, binds with and cross-links cellulose fibers	Yes

Image from Becker et al. (2019), and Luong et al. (2012)

Properties Evaluated

Human and Environmental Hazards

Thermal Properties

Barrier Properties

Chemical Properties

Surface Properties

End-of-Life Properties

Mechanical Properties

Image from US Foods

Properties Evaluated

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Thermal Properties

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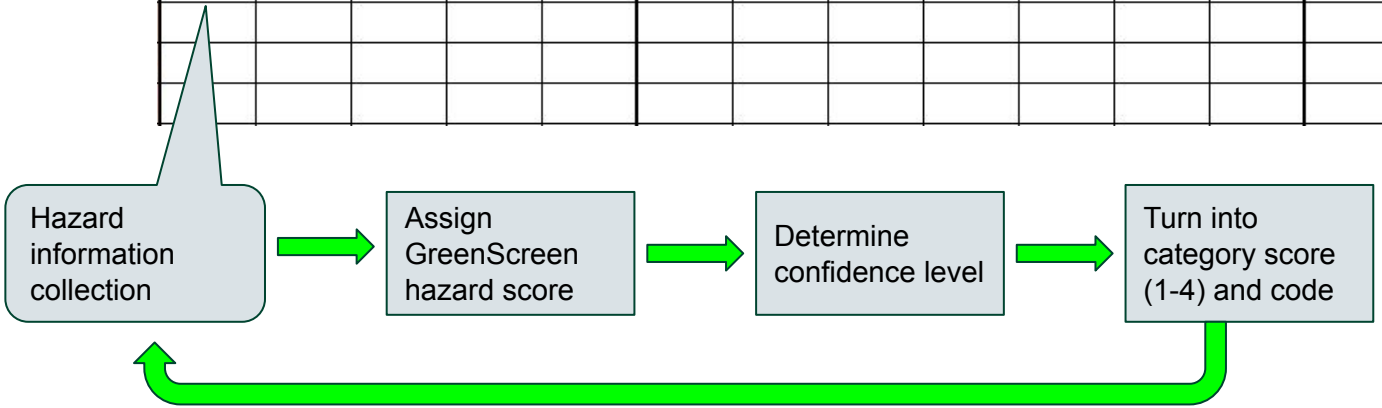
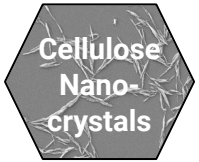
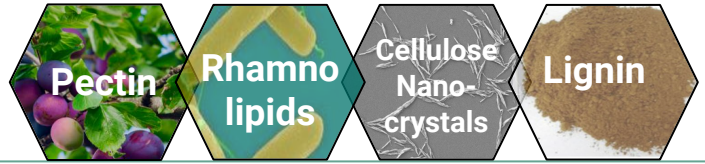
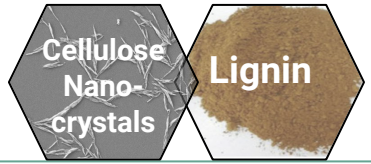
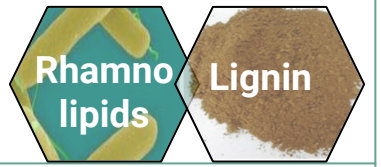
Evaluating toxicities, step-wise:

Group I					Group II and II*							Ecotox	Fate	
C	M	R	D	E	AT	ST	N	SnS*	SnR*	IrS	IrE	AA/CA	P	B



	Hazard improvements to PFAS	Notes
	Safer on multiple orders of magnitude for known Group I/II endpoints; non-persistent and non-bioaccumulative	Several hazard data gaps; microbial product
	Safer on multiple orders of magnitude for known Group I/II endpoints; non-persistent and non-bioaccumulative	Includes acid digestion of cellulose
	Novel technology; Safer on multiple orders of magnitude for known Group I/II endpoints; non-persistent and non-bioaccumulative	Some amount of uncertainty
	Largely benign, represents most significant hazard reductions; non-persistent	Utilization of waste product

Possible Usage of Alternatives

Possible Alternatives			
Food Type			
Temperature	Room Temp	Hot	Hot
Water Content	Medium	Low	Medium
Oil Content	Low	High	Medium

Images from Shopify, Fast Company, BrenMarco

Thank you!

Special thanks to

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