

# Utilizing Biomatter to Engineer Sustainable Hierarchical Materials

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***Eleftheria Roumeli***

*Materials Science & Engineering, University of Washington*

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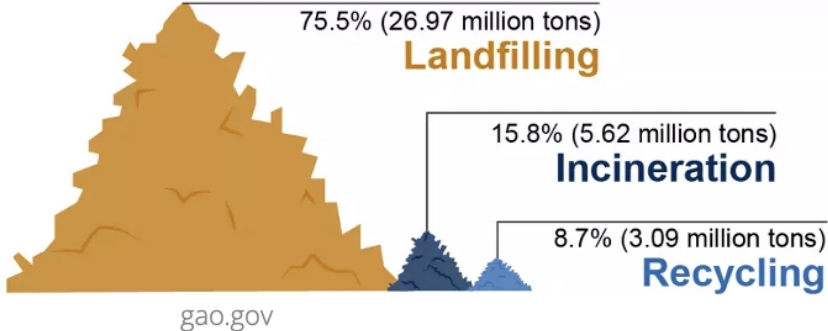
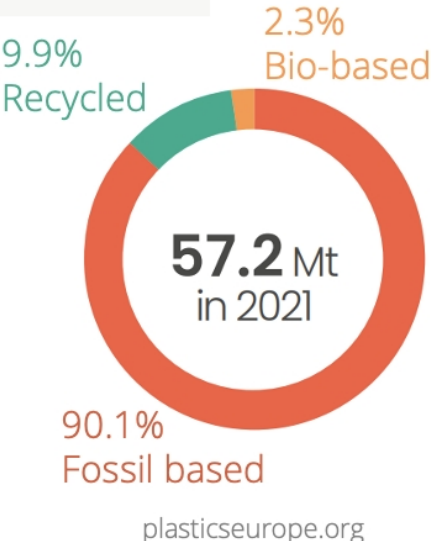
# Challenges in the Age of Plasticene

Sourcing

Supply Chains

End of Life

EU 2021



A piece of "plastiglomerate"



deccanherald.com

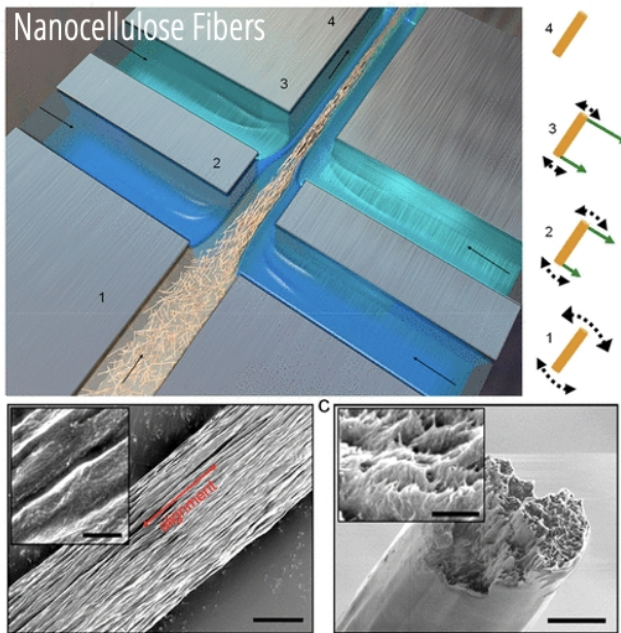


The Great Pacific Garbage Patch

forbes.com

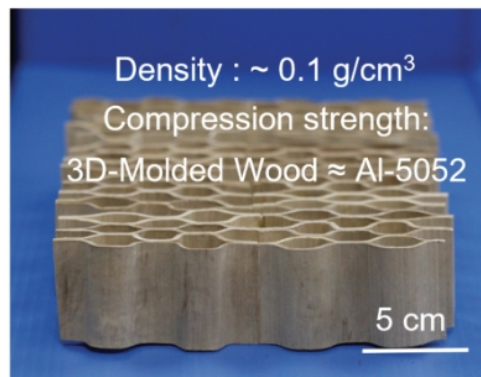
# Sustainable solutions from biopolymers & natural nanocomposites

## Biopolymer assemblies



Mittal, N. et al. Multiscale control of nanocellulose assembly: transferring remarkable nanoscale fibril mechanics to macroscale fibers. *ACS nano* 12 (2018)

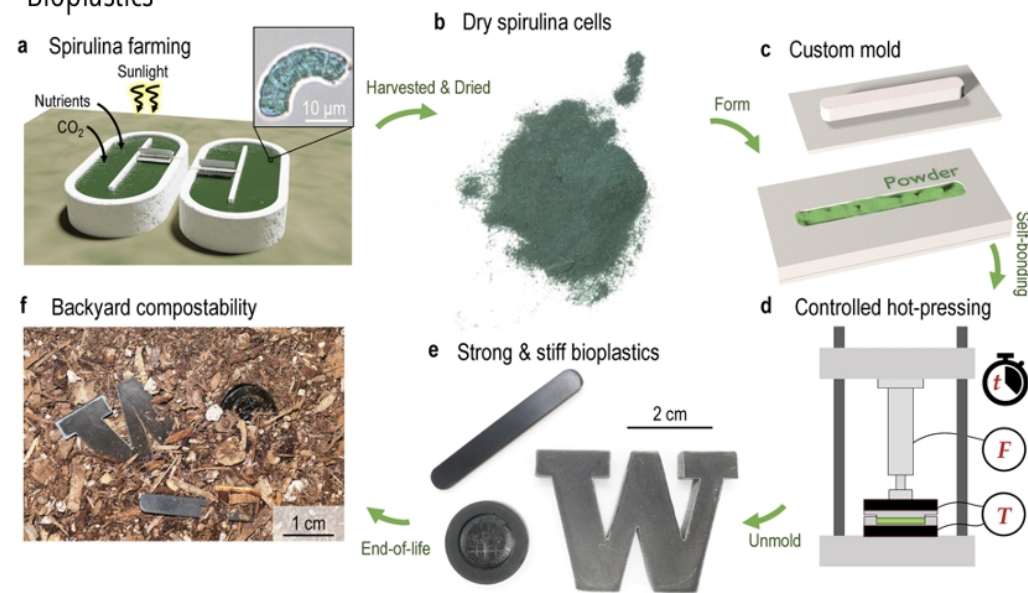
## Hierarchical nanocomposites



Xiao, S., et al. Lightweight, strong, moldable wood via cell wall engineering as a sustainable structural material. *Science*, 374 (2021)

## Entire biomatter utilization

### Bioplastics

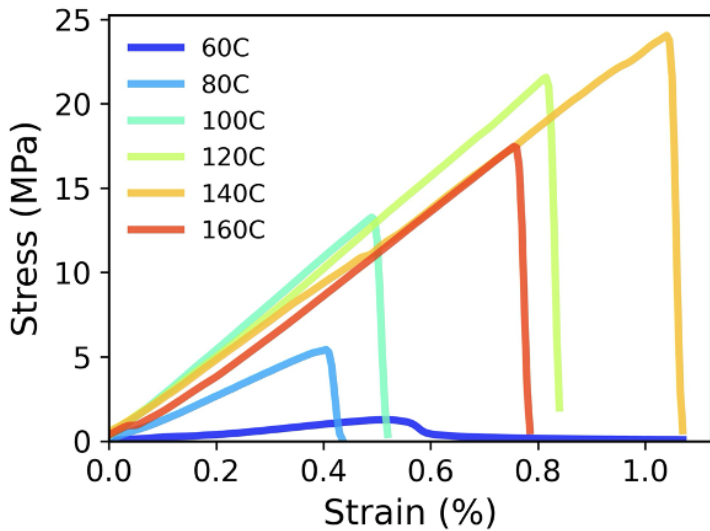
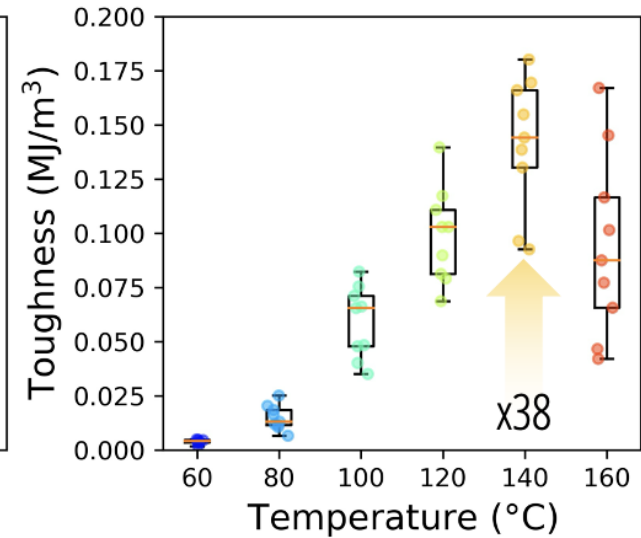
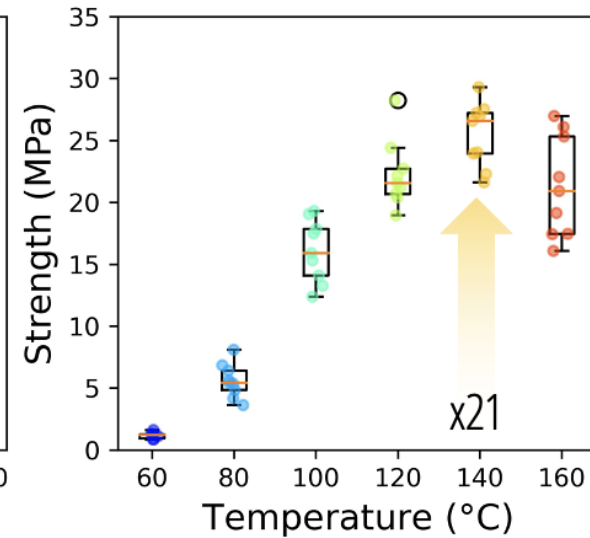
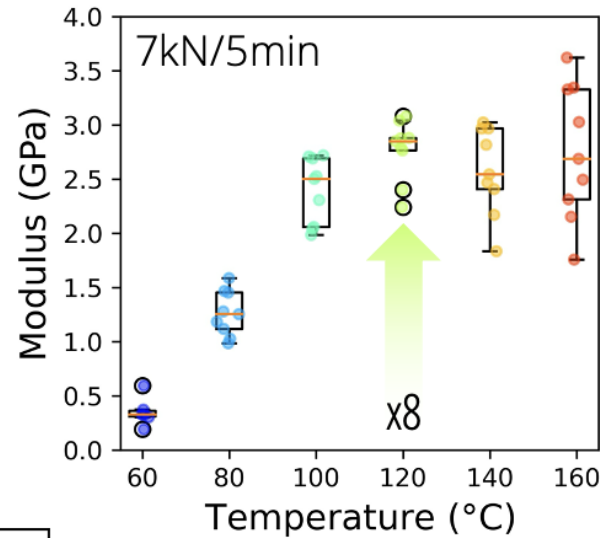
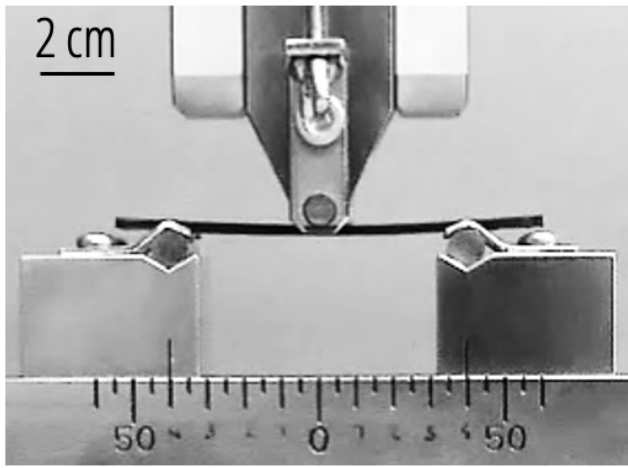


Iyer H. et al. Fabricating Strong and Stiff Bioplastics from Whole Spirulina Cells, *Adv. Fun. Mater.* (2023) 2302067

- Campbell, I. & Lin, M.-Y. et al. Progress in Sustainable Polymers from Biological Matter. *Annu. Rev. Mater. Res.* 2023, vol 53
- Fredricks, J. L. et al. Hierarchical Biopolymer-Based Materials and Composites. *J. Polym. Sci.* 2023



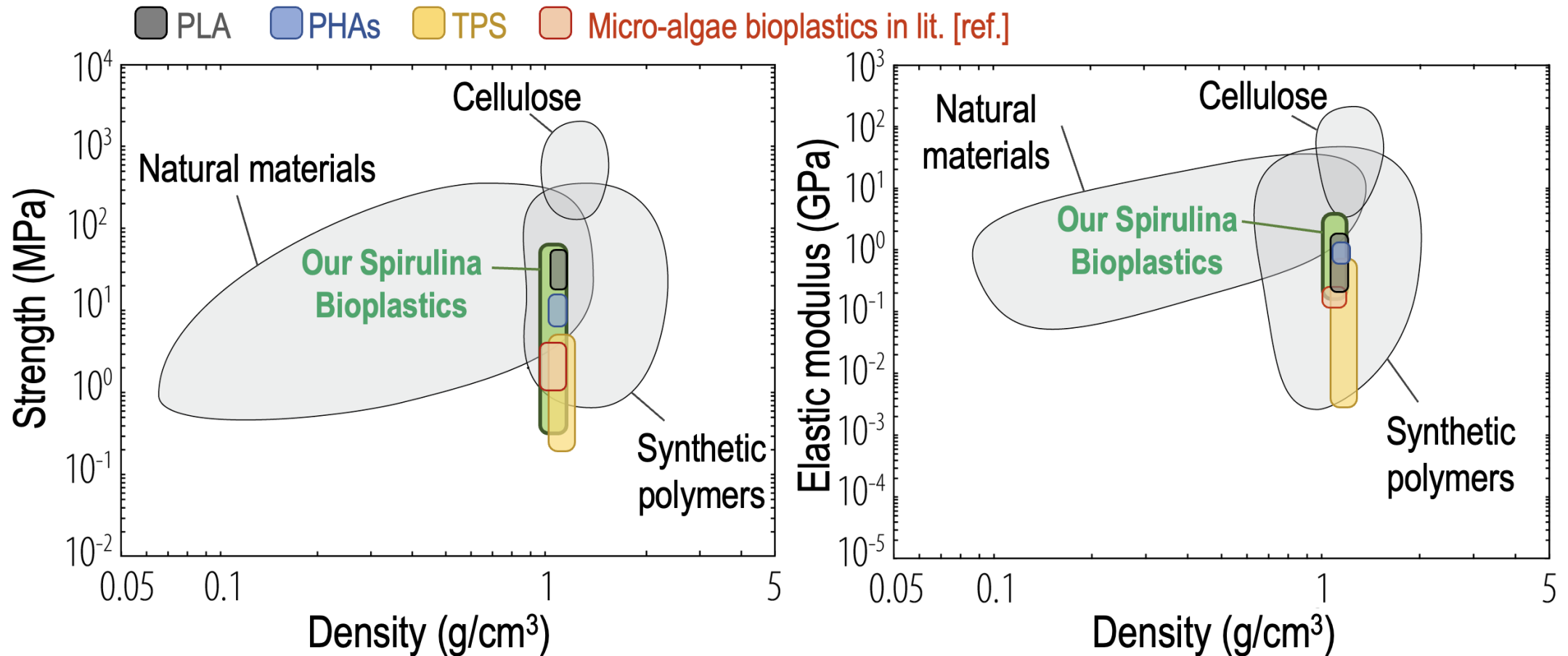
# Processing to control mechanical performance of spirulina bioplastics



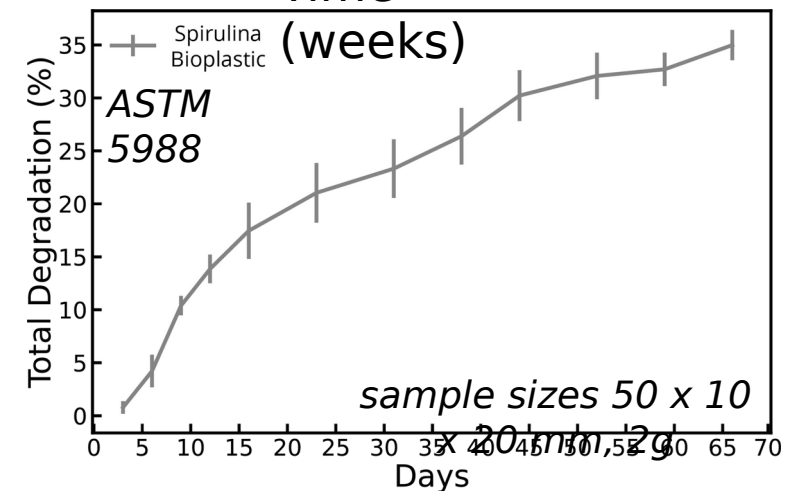
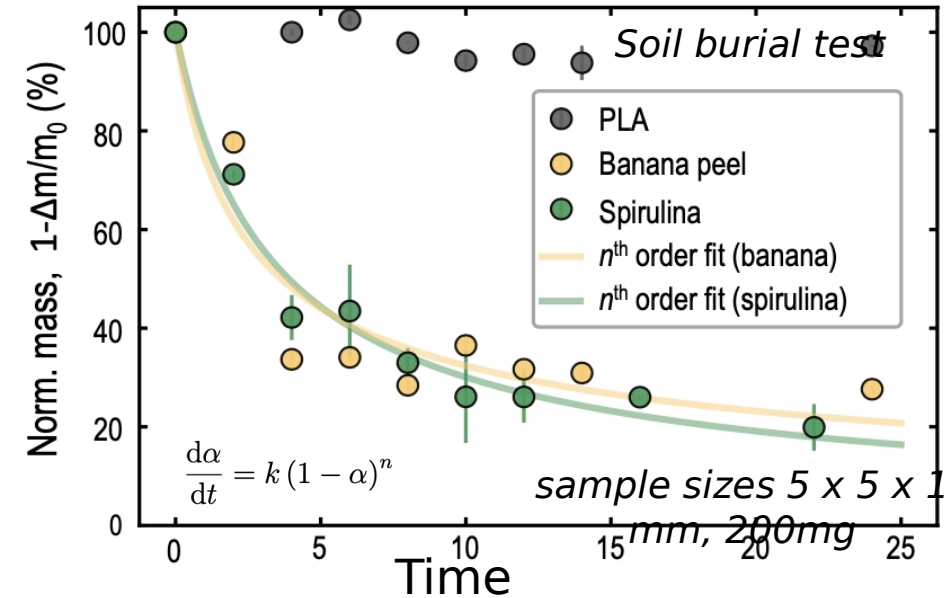
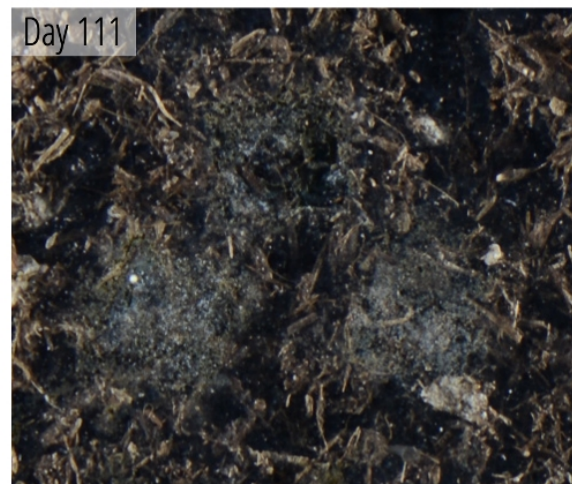
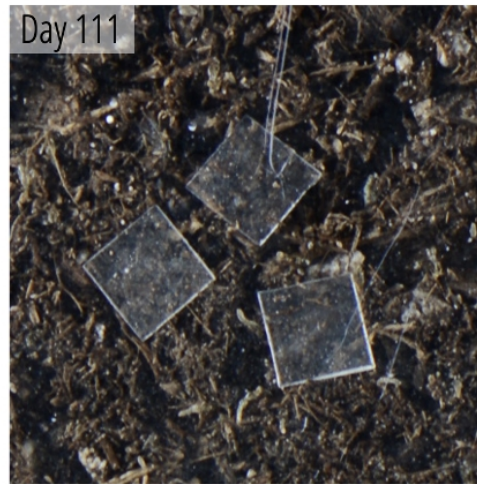
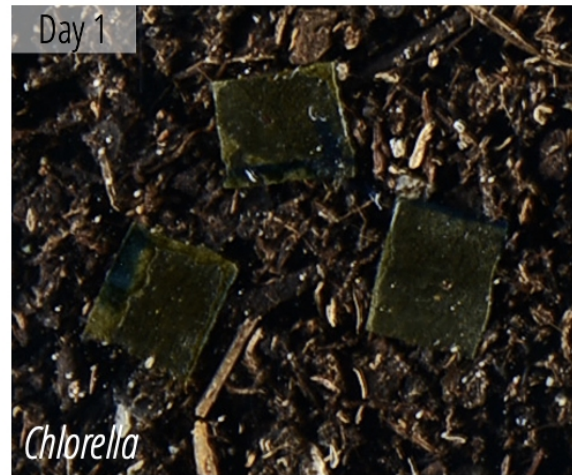
- DOE to explore design space of processing parameters {pressure, temperature & time}



# Bioplastics landscape

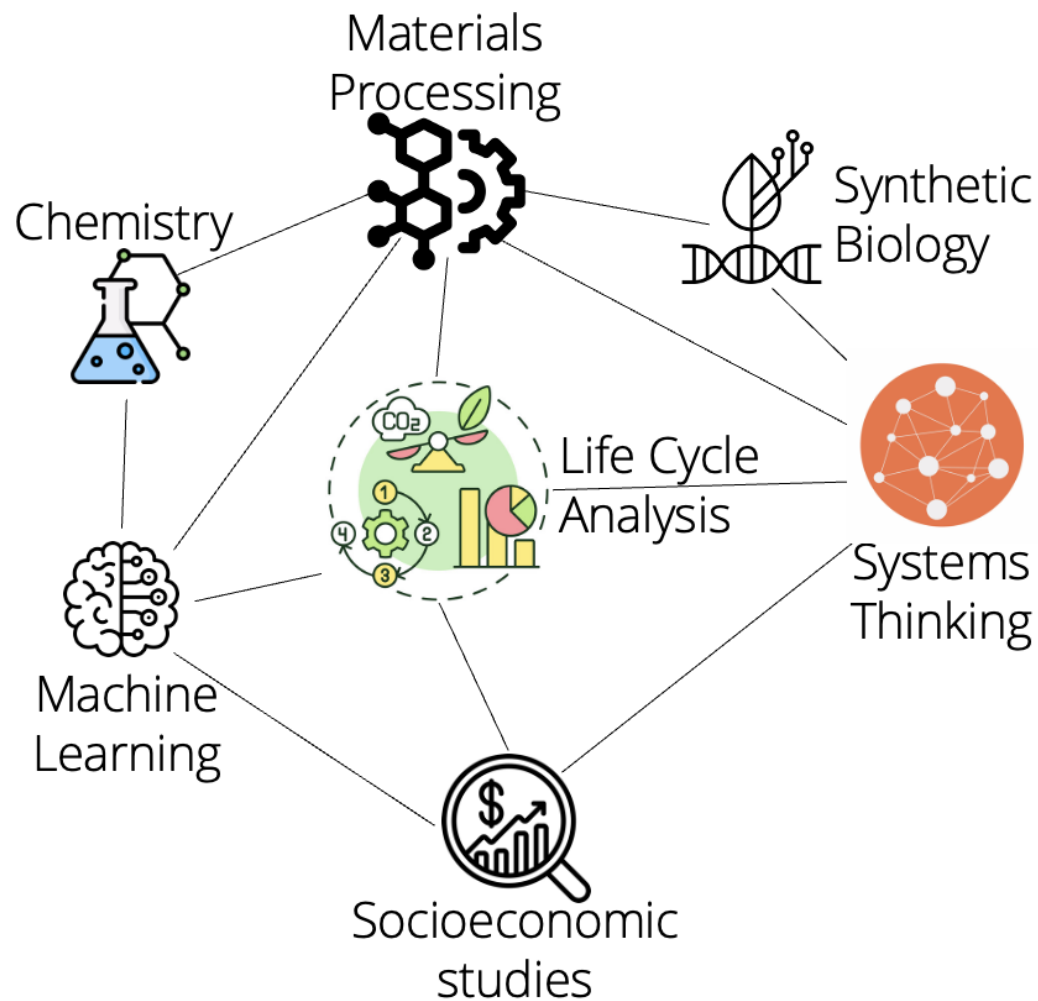


# Biodegradation in soil



# Sustainable materials manufacturing vision

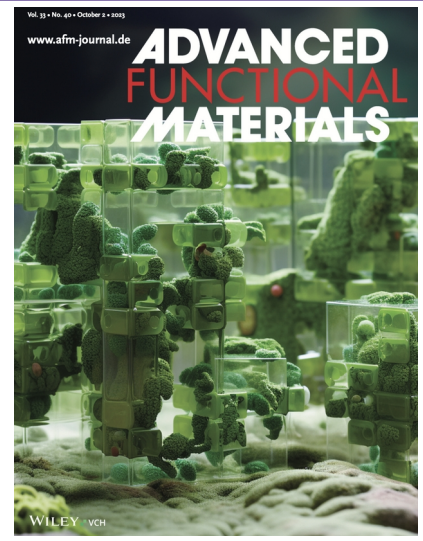
- In situ resource utilization
- Biorefinery approach
  - Enabled by accelerated materials design & advances in synbio ⊥ materials science
- Integration to local communities
- “Controllable” end of life
- Waste management (closing loop)



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- *Brandon Lou*
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Contact:  
[eroumeli@uw.edu](mailto:eroumeli@uw.edu)  
@ERoumeli

