Combining tannins with cellulose nanofibrils towards functional materials

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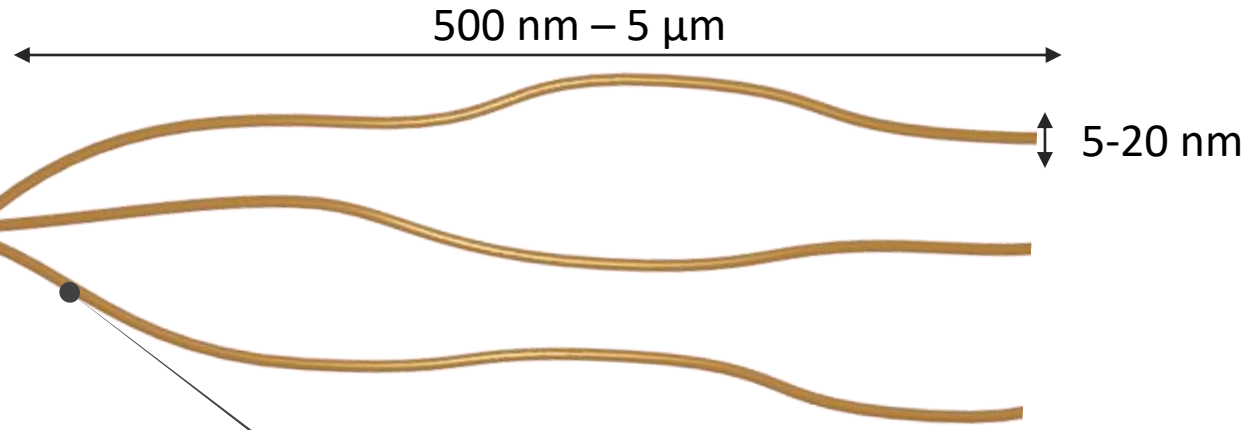
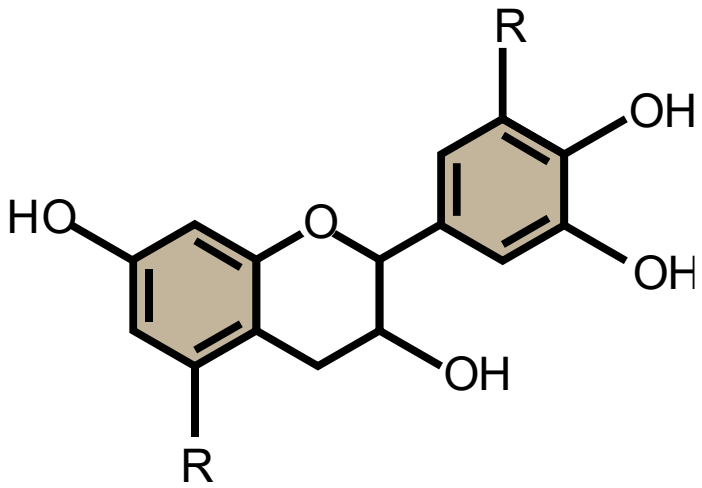


Cellulose nanofibrils

Structural building block

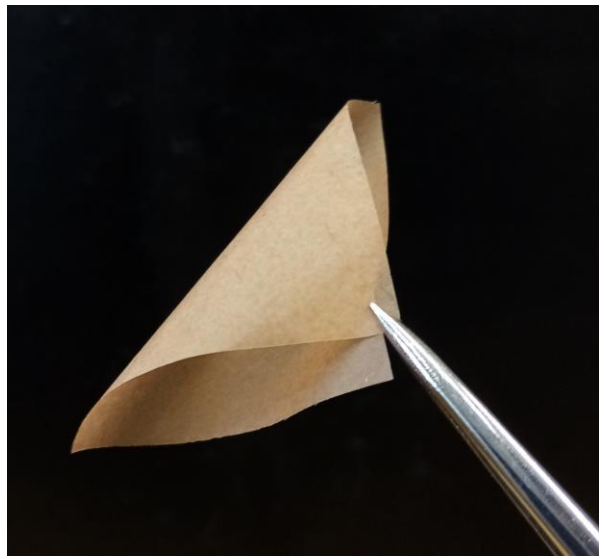
Strong - Flexible - Engineerable



Condensed tannins

Functional components

Reactive - active - water soluble



- Antioxidant
- Hydrophobic
- Strong
- Tunable

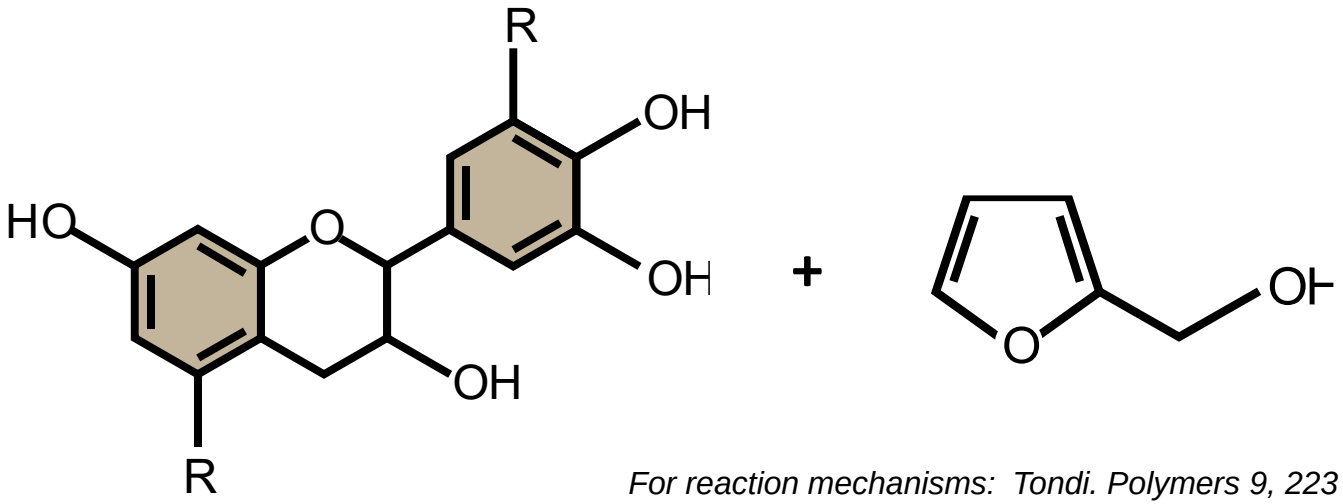
  Tannin purification

  Additives

Missio et al. J. Clean. Prod. 184, 143-151, 2018.

Missio-Mattos-Otoni et al. Biomacromolecules 21,1865–1874, 2020.

Tannin-Furanic Rigid Foams



For reaction mechanisms: Tondi. Polymers 9, 223 2017.
Pizzi. Biomolecules 9, 344, 2019.

Self-blowing mechanism

Condensed tannins

Furfuryl alcohol

Volatile organic solvent

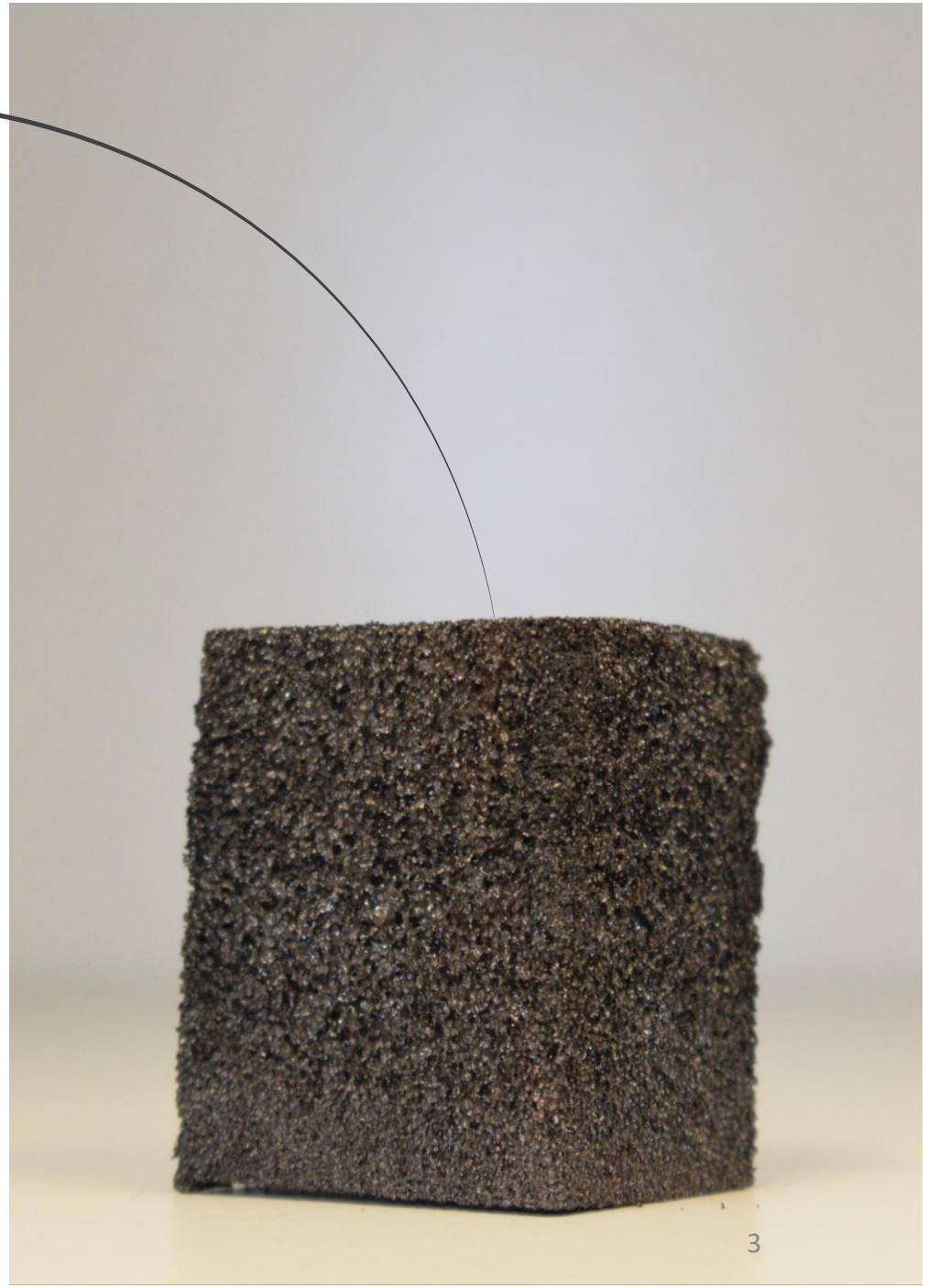
Acid catalyst

~~Formaldehyde (crosslinker)~~

Water

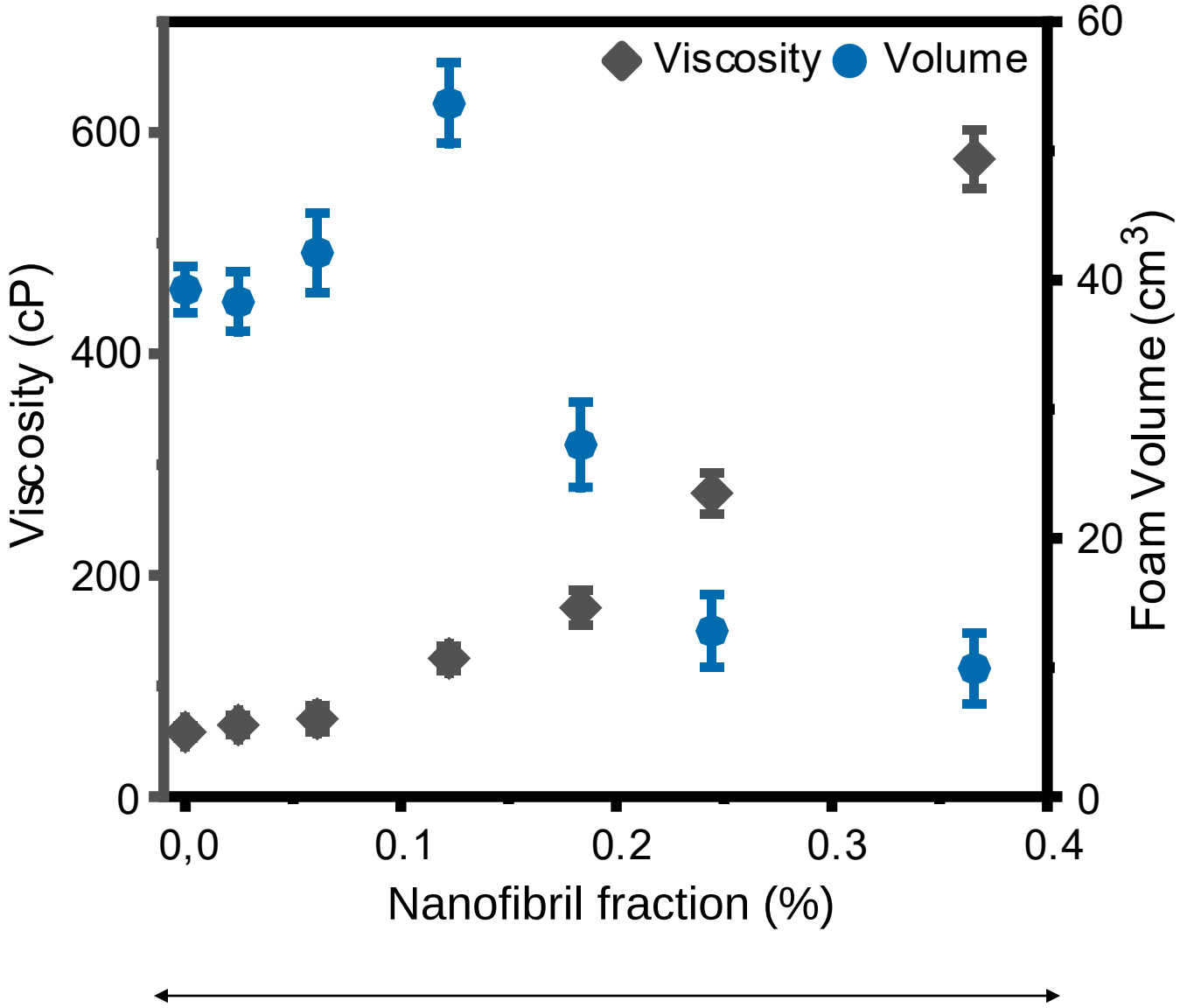
Cellulose Nanofibrils

(physical crosslinker)



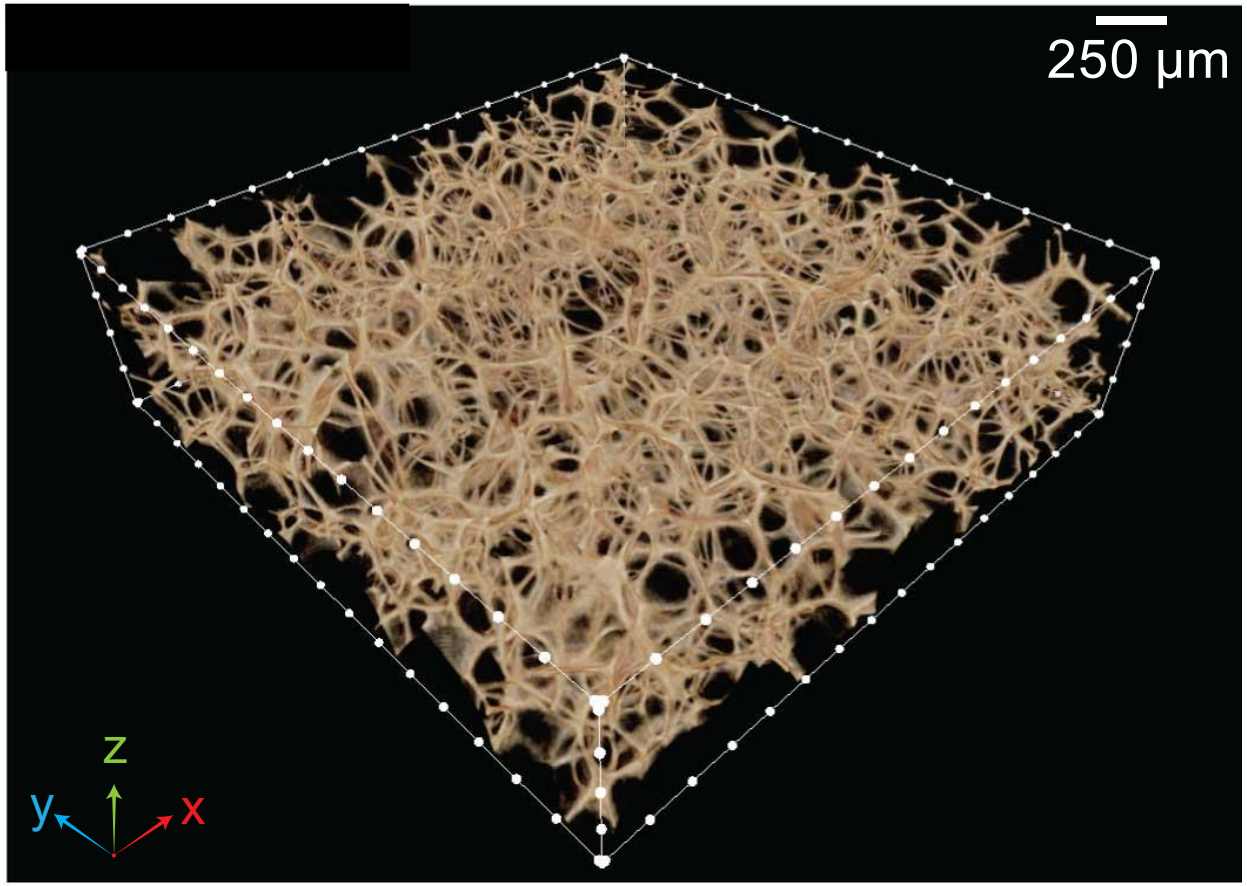
Our recipe

Condensed tannins
Furfuryl alcohol
Volatile organic solvent
Acid catalyst
~~Formaldehyde~~
~~Water~~
Cellulose nanofibrils
Suspensions



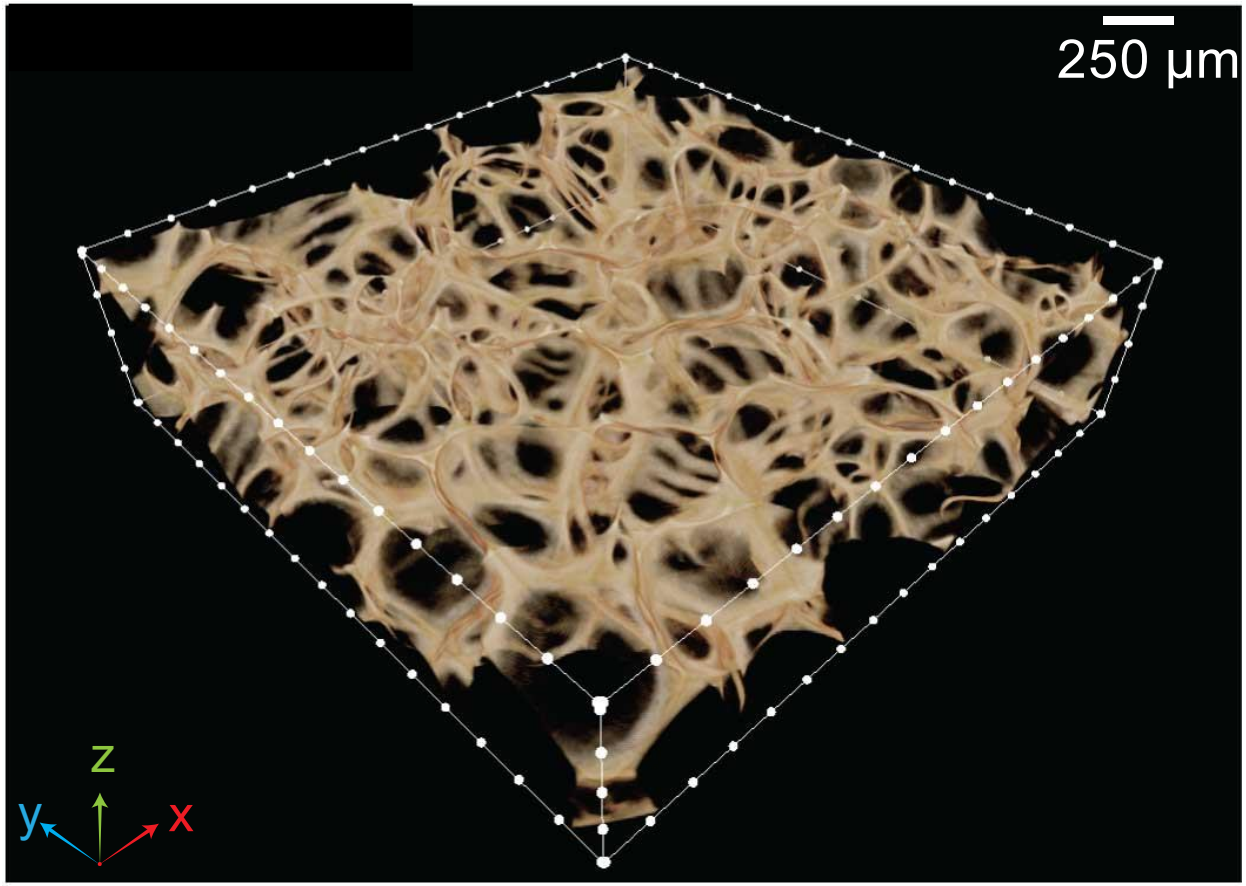
Suspensions at 0.1 – 1.5 wt%

Formaldehyde



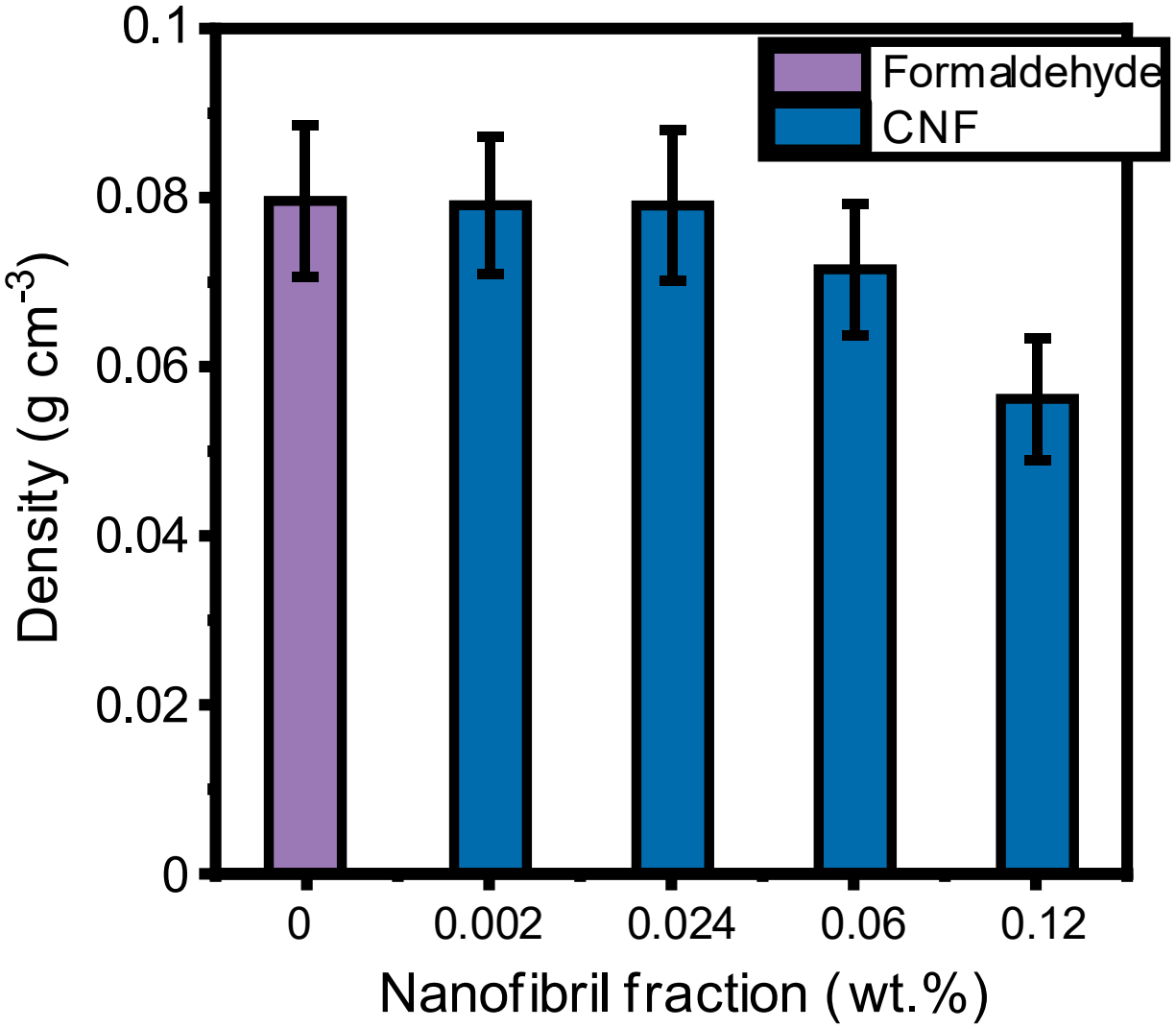
Smaller cells
Thinner walls

CNF

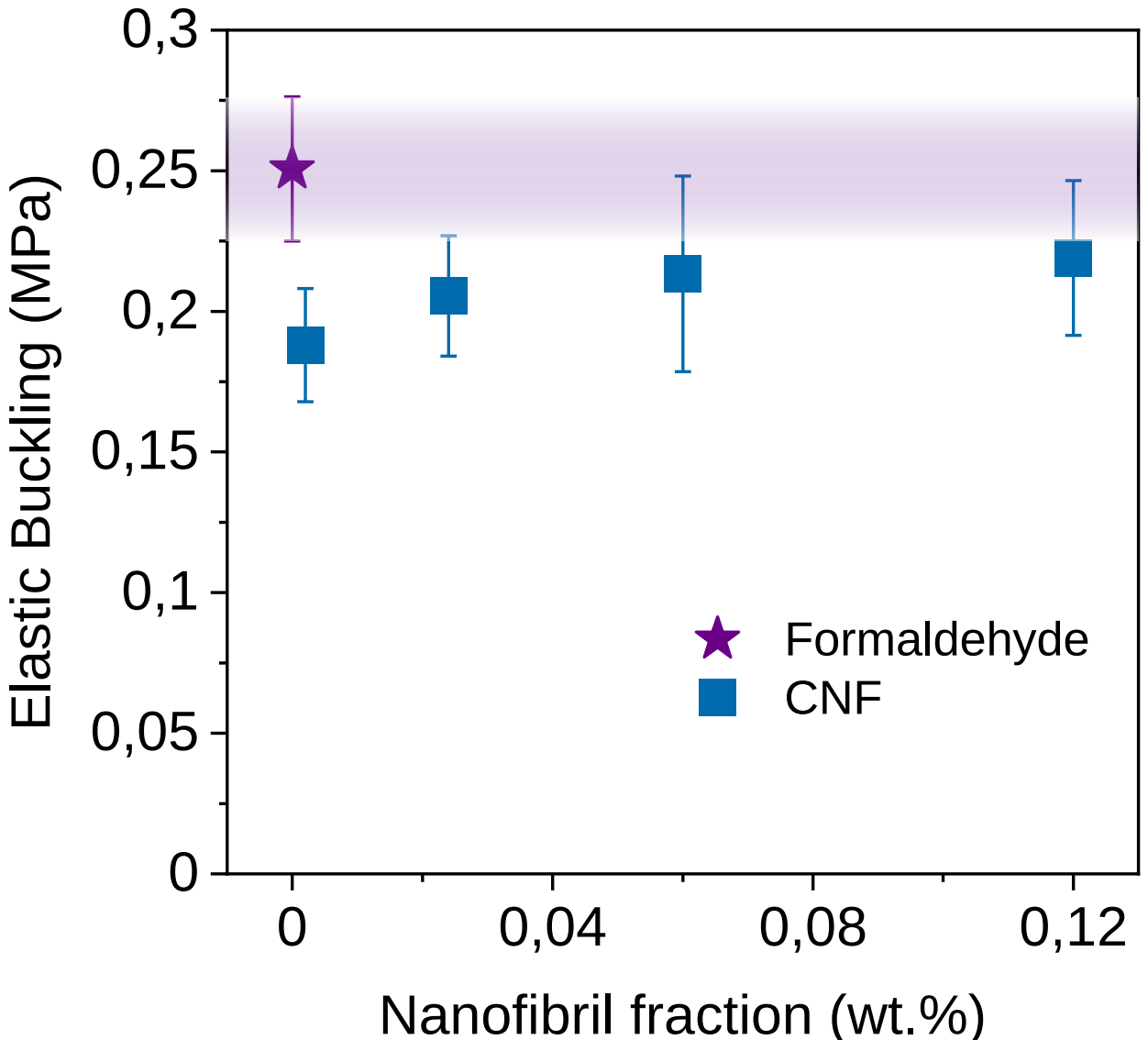


Bigger cells
Thicker walls

Tannin/CNF rigid foams are light weight



Formaldehyde is not needed!



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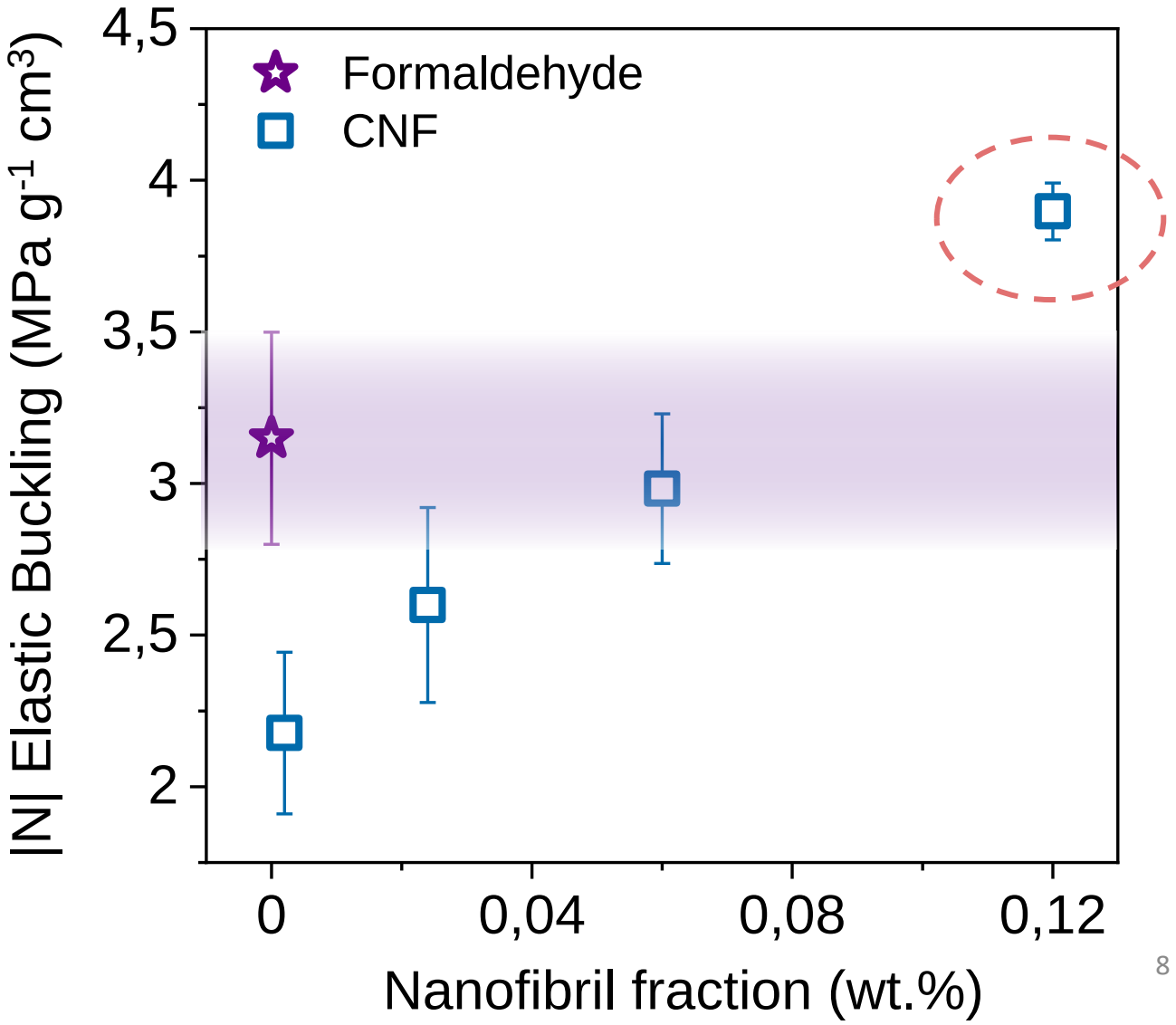


Sandwiched Foam

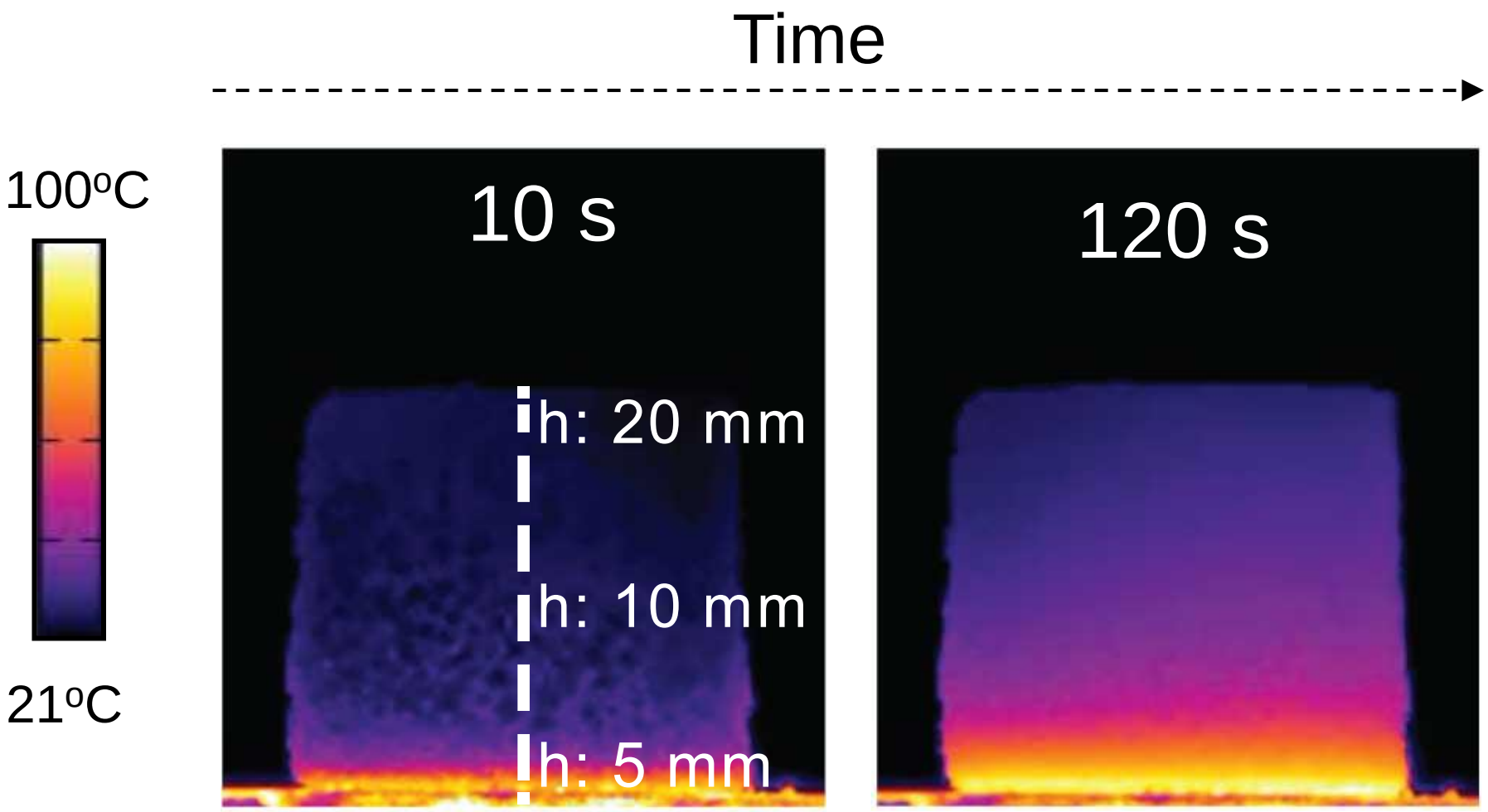
Structural wood veneers

Tannin-CNF insulator component

Veneer: 0.13 W/mK

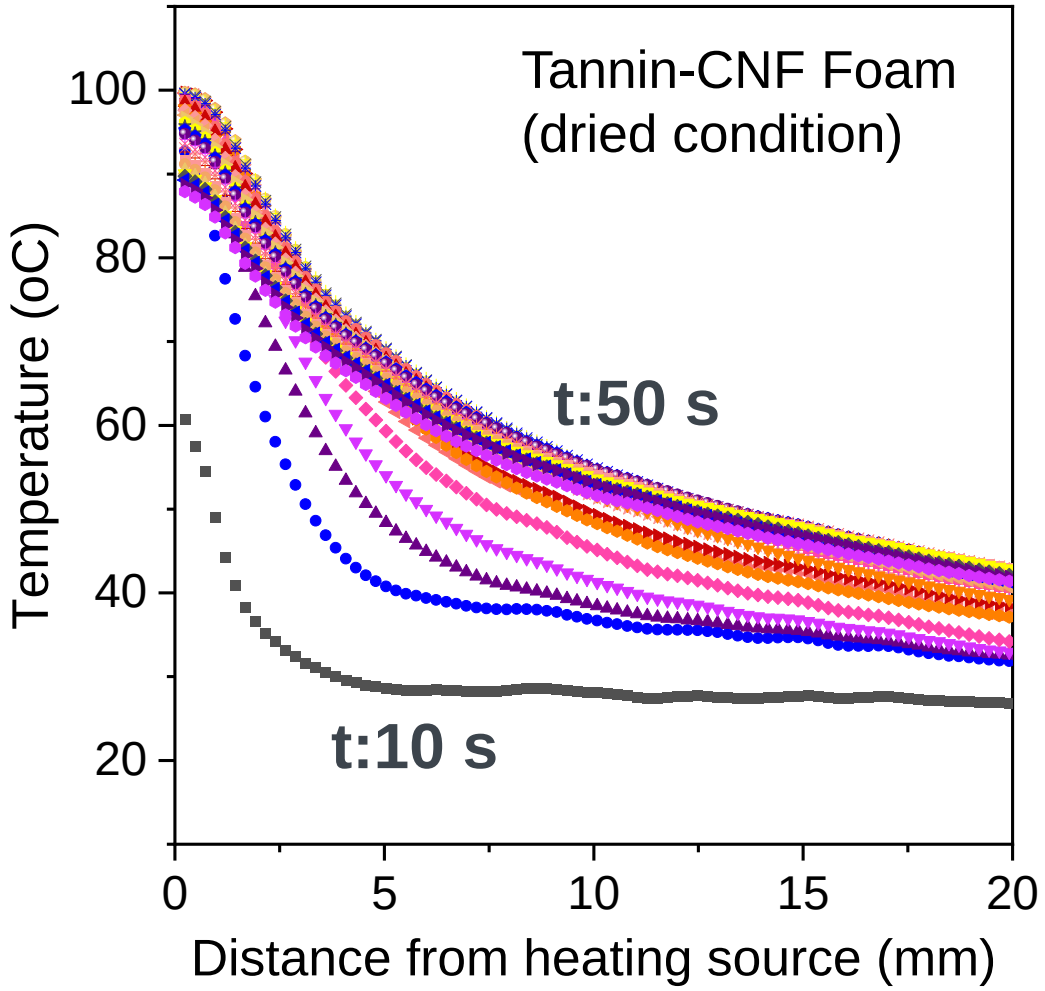
Foam: 0.03 W/mK

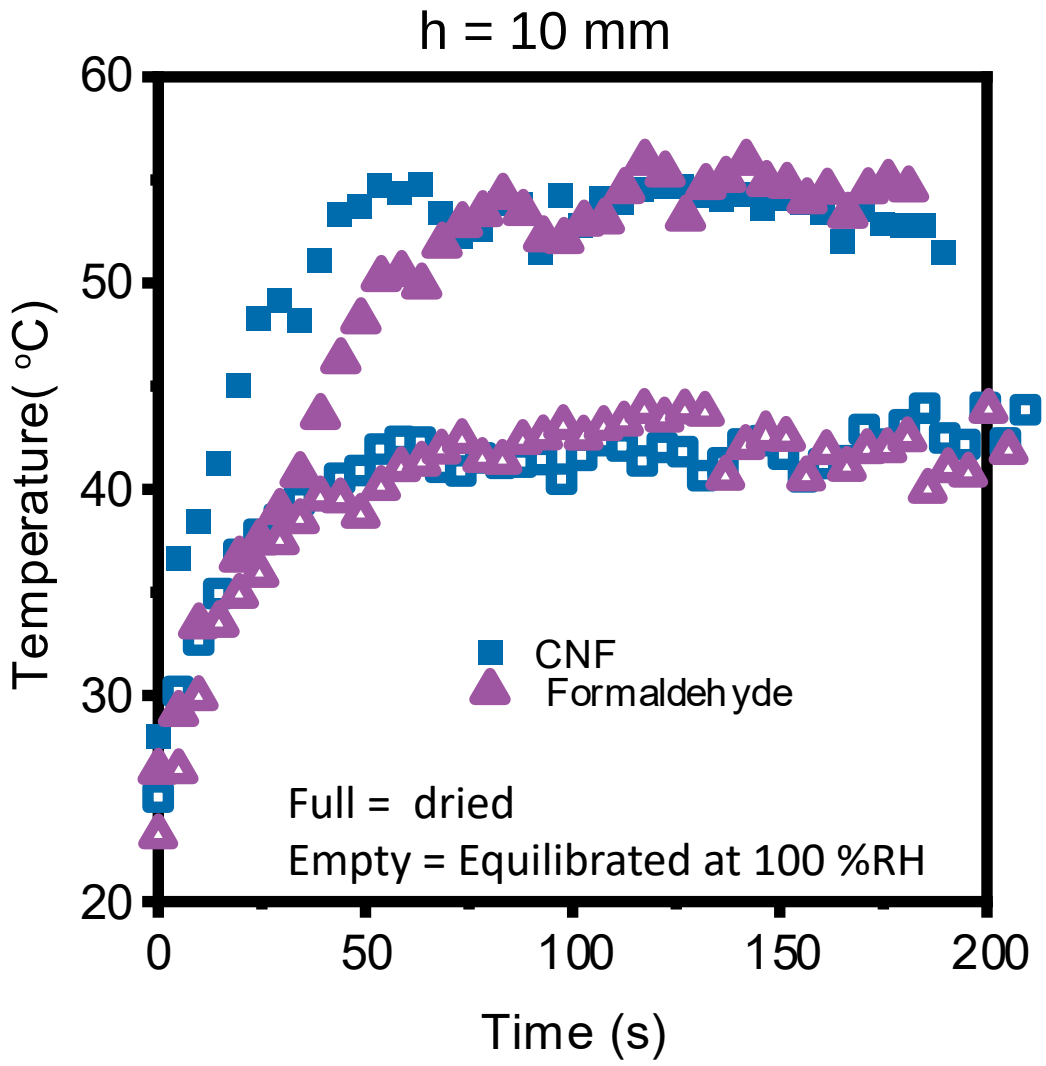
Framework for thermal evaluation

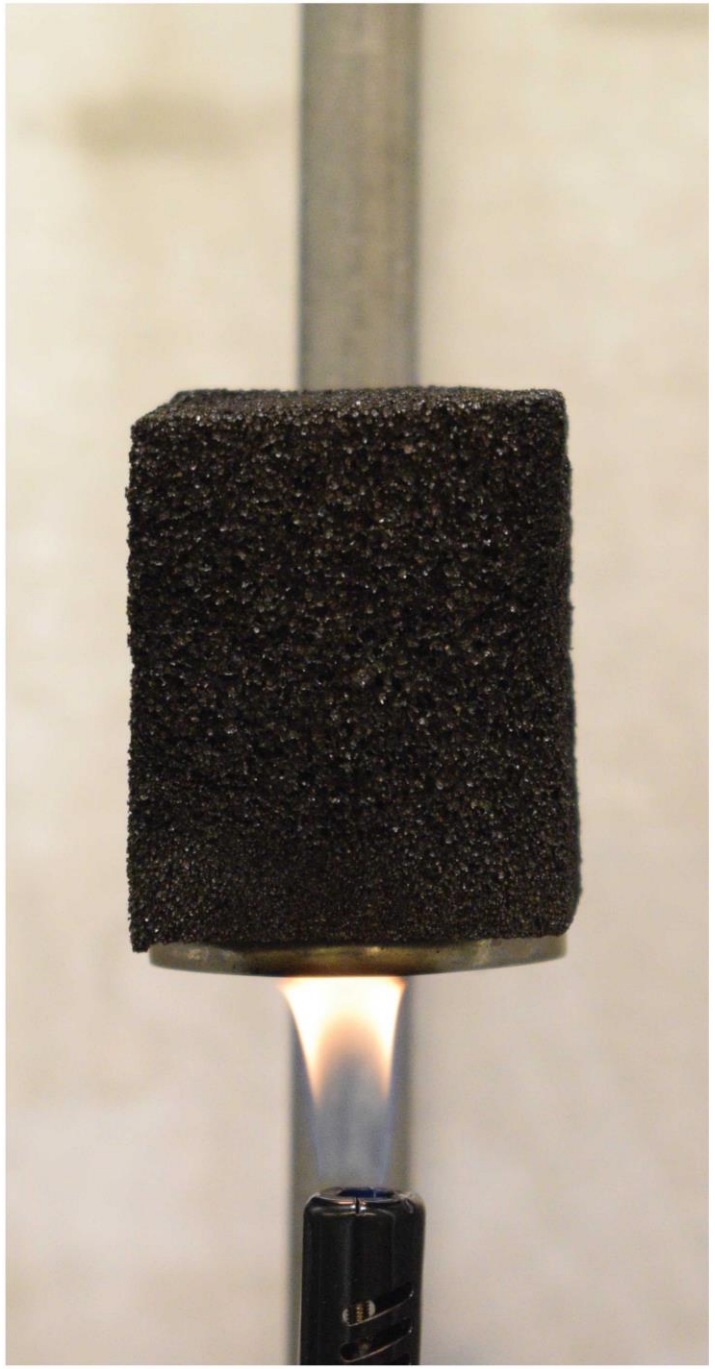


Heating source set at 100 ºC

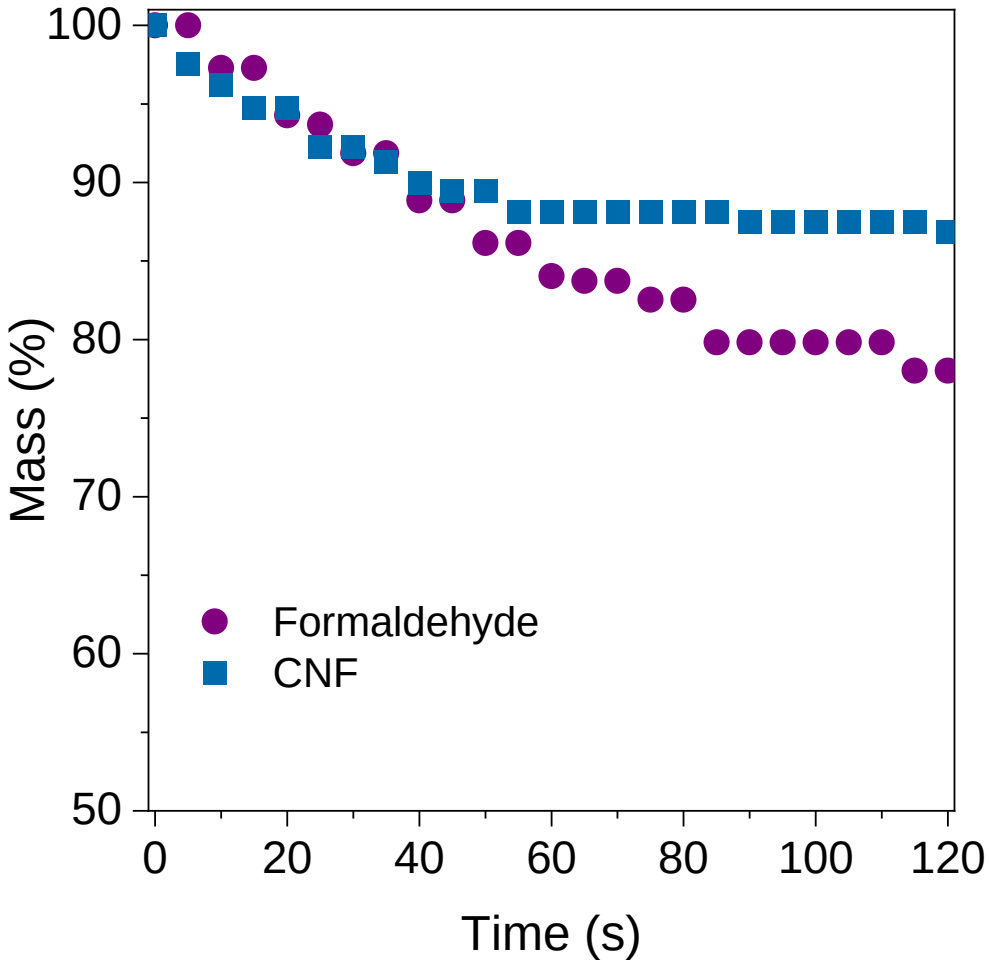
Tannin/CNF rigid foams are very thermal stable!

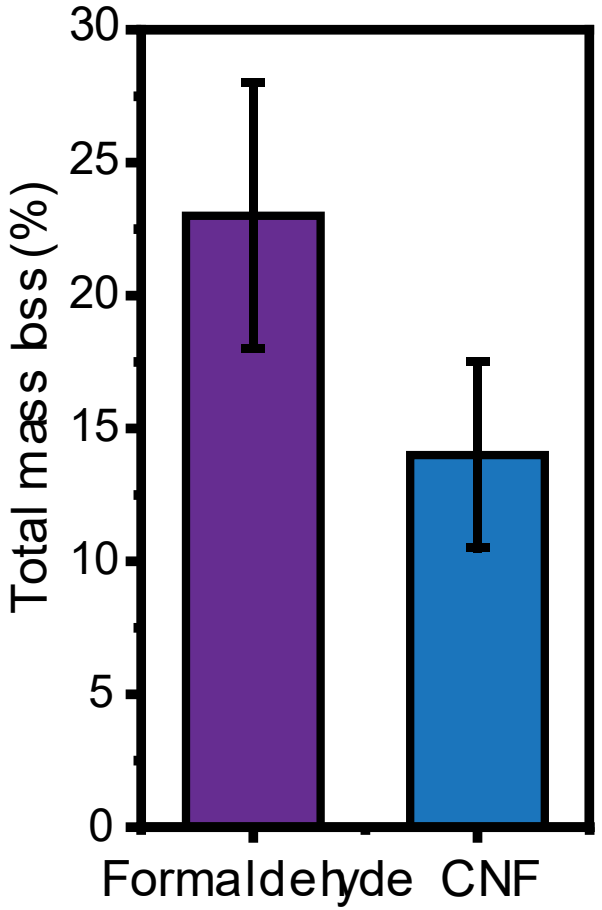






Tannin/CNF rigid foams are anti-flame!





Anti-flame & Insulator

~~Formaldehyde~~ ➡ CNF

+ Stronger

+ Lighter

+ Greener

Thank you!

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