International Conference on Nanotechnology for Renewable Materials

Air dried clay/lignocellulose foam for fire-retardant thermal insulation

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TAPPI NANO DIVISION

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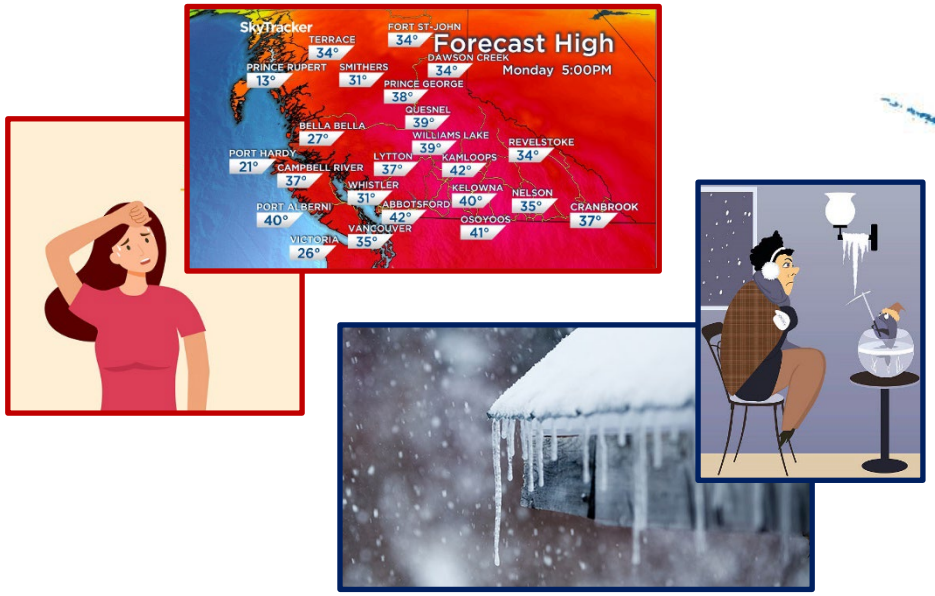
Pricey active thermal regulation



Canada

~90 Million tons CO_2 equivalent in 2021

(source: https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/greenhouse-gas-emissions.html)

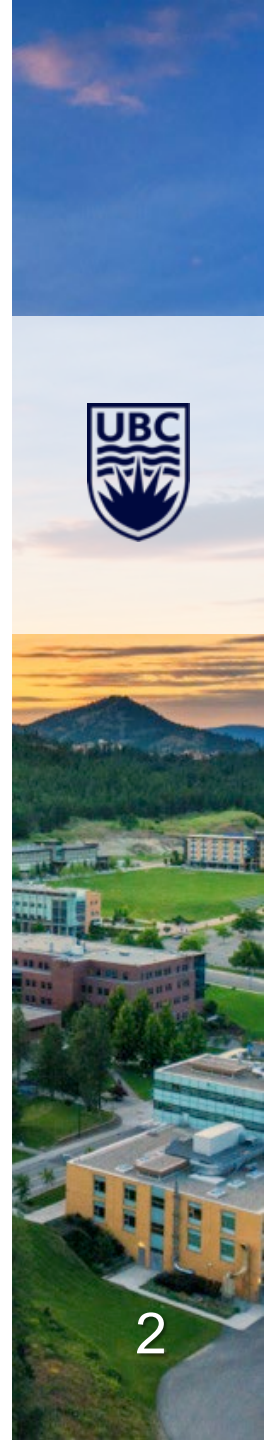
United States

>800 Million tons CO_2 equivalent in 2021

(source: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions)

- Coal, natural gas, syngas, etc.
- 13-16% of the overall GHG emissions in both countries (2021)

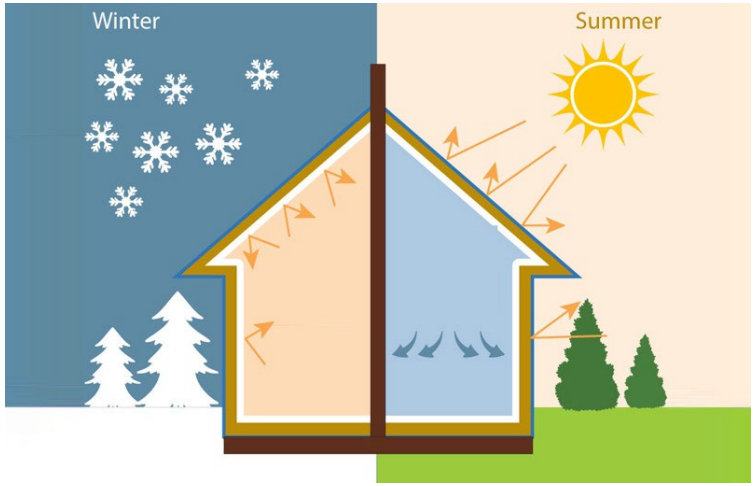
https://www.burnsandwilcox.ca/insights/bitter-cold-heavy-snow-slam-homeowners-businesses-across-u-s/
https://globalnews.ca/news/7975968/heat-dome-warnings-record-breaking-temperatures-forecast-bc/



Passive thermal regulation

Thermal insulation

- Global market: ~ US$ 32 billion (2021)
- Polymer foams & mineral mats: 95%



X Non-renewable

X Non-biodegradable

X Inflammation

X Inhalation concerns

Insulative materials based on lignocellulose

Major products in market

- Blown-in cellulose
- Wood fiberboard

What we want?

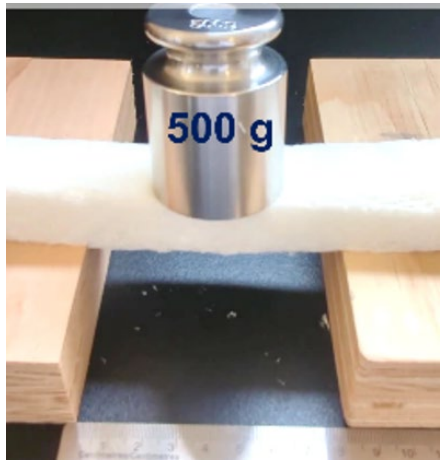
- ➢ Water/moisture resistance
- ➢ Fire retardancy
- ➢ Cost effectiveness

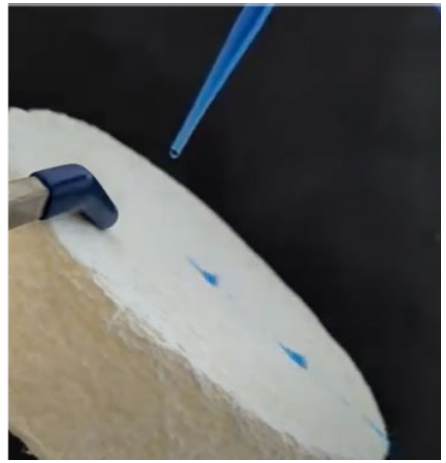
https://fdinsulation.com/attic-insulation/cellulose/
https://www.eco-home-essentials.co.uk/wood-fibre-insulation.html
https://inspectapedia.com/insulation/Cellulose_Insulation.php
https://www.subrogationrecoverylawblog.com/2012/10/25/material-failure-focus-on-cellulose-insulation/

Our previous work on hydrophobic lignocellulose foam

Lignocellulose foam

- Lightweight (10-200 kg/m^3 or 0.62-12.5 lb/ft^3)
- Mechanical robustness
- Improved water repellency



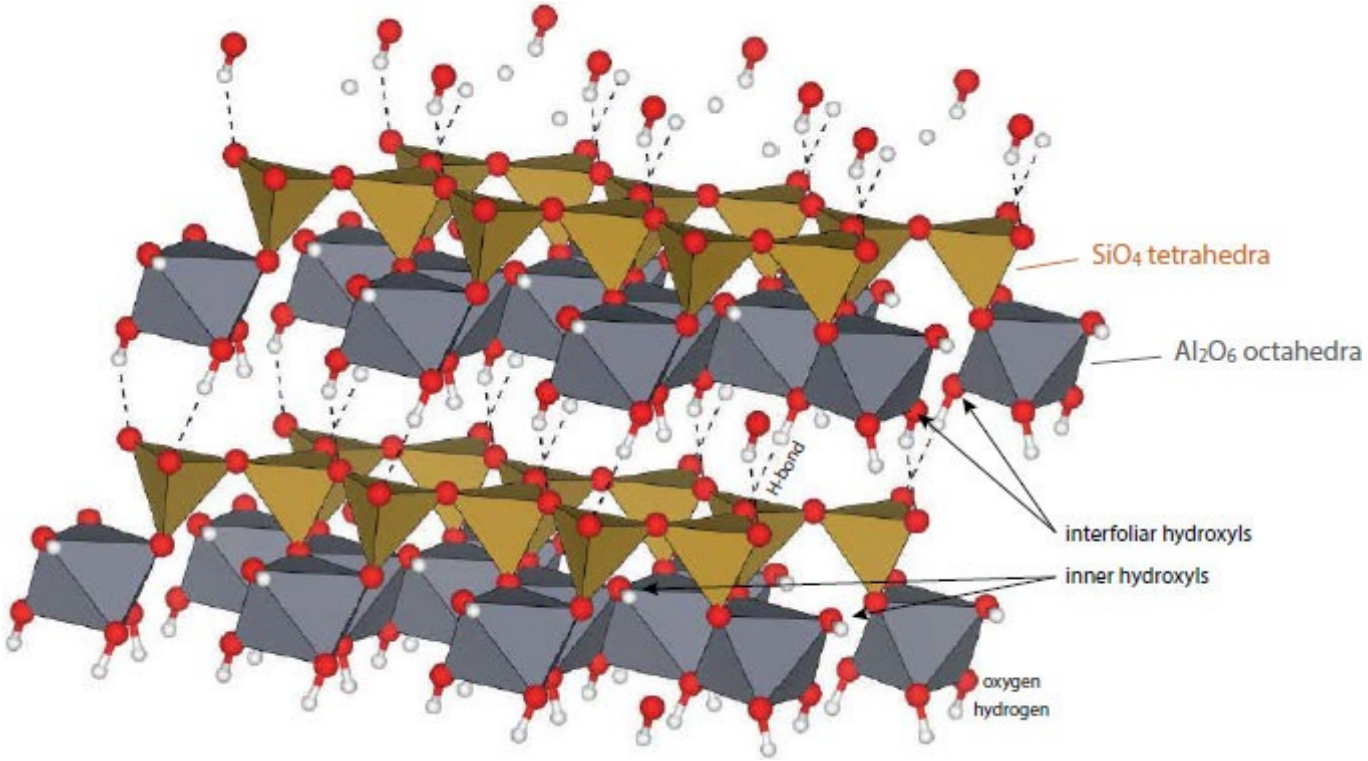


https://doi.org/10.1016/j.cej.2022.138300

Scope: fire-retardant lignocellulose foam

Nanoclay as environmentally-benign fire-retardant filler

- Feedstocks derived from nature
- Hassle-free disposal
- Recyclability

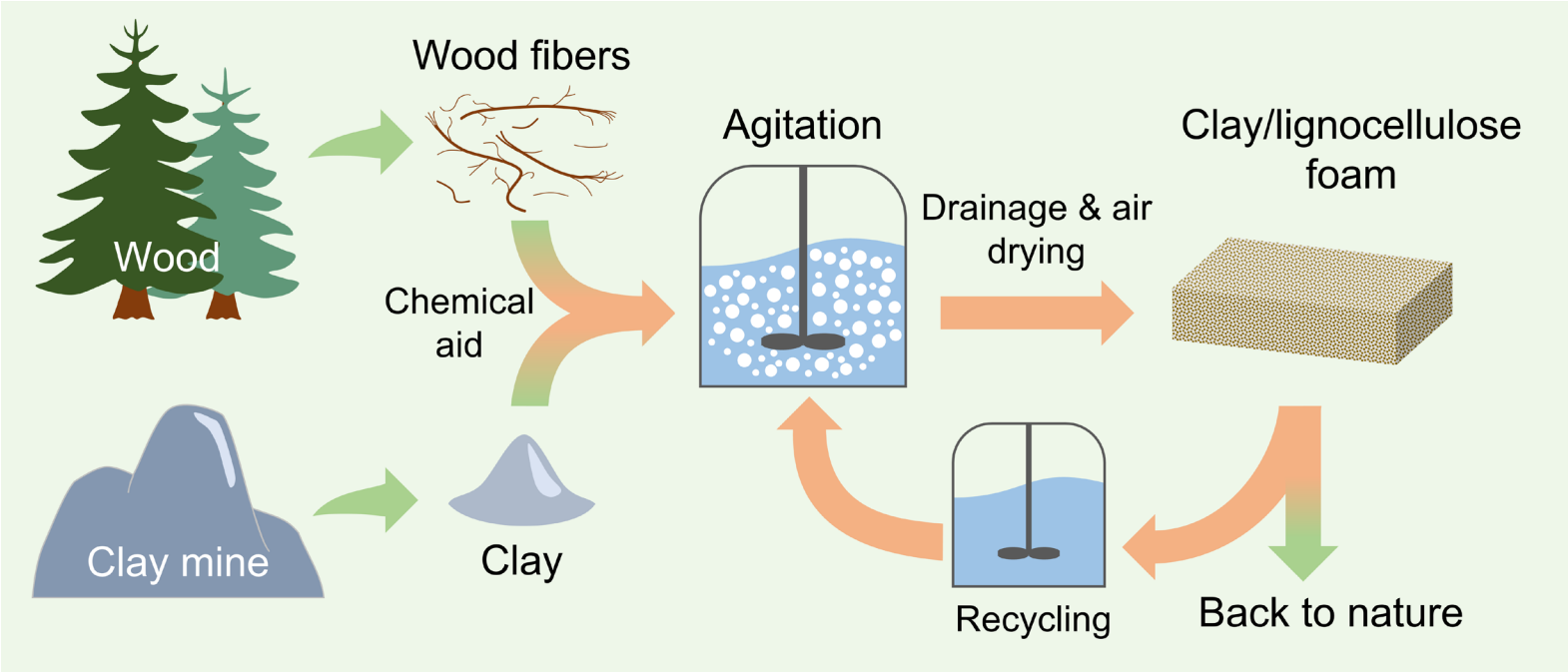


Manuscript submitted
https://doi.org/10.2138/am-2022-8025

Air dried clay/lignocellulose foam

Formulation development based on design-of-experiment (DOE)

- Density, thermal conductivity, mechanical, and fire retardancy



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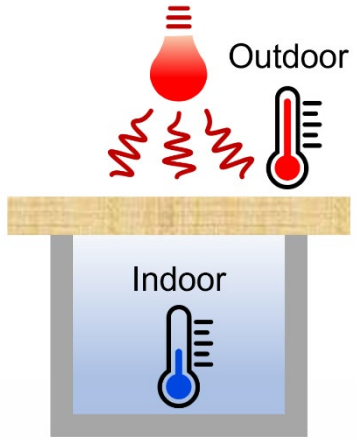
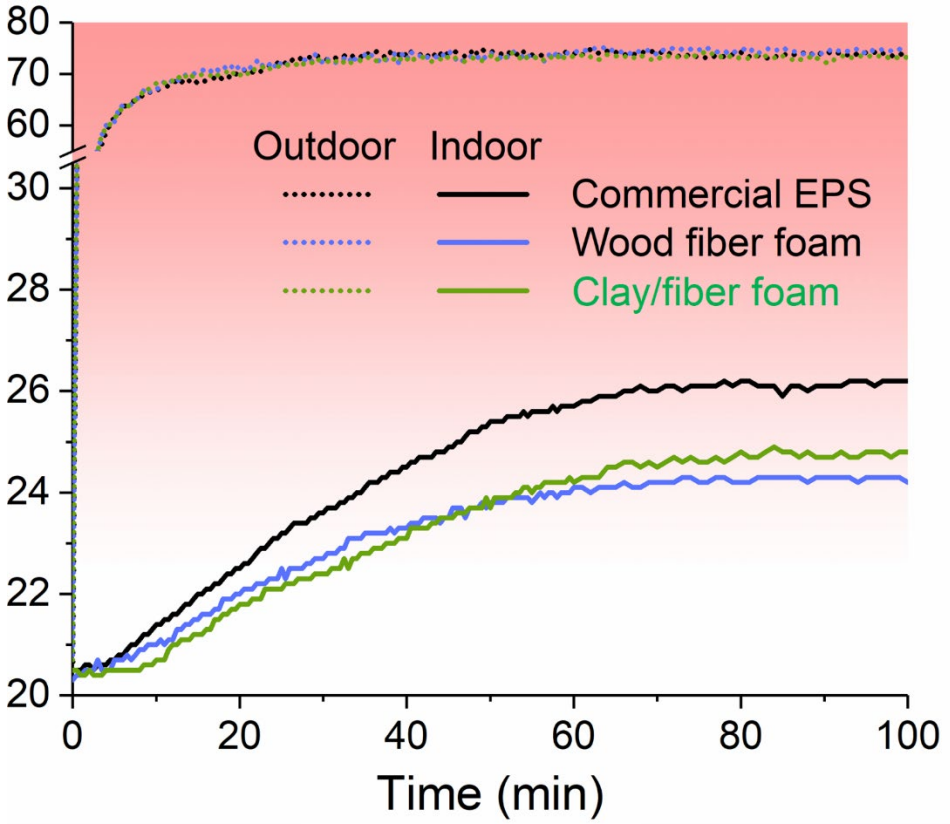
Thermal insulation

Thermal conductivity of 36.2 – 43.7 mW/(m·K)



Materials	*R-value /in*
Clay/lignocellulose foam	**3.3 – 4.0**
Glassfiber	3 – 4.2
Mineral wood	3 – 3.2
Plastic board	3.7 – 6
Spray foam	3 – 7
Blown-in cellulose (fresh)	3.3 – 3.6
Others	< 3



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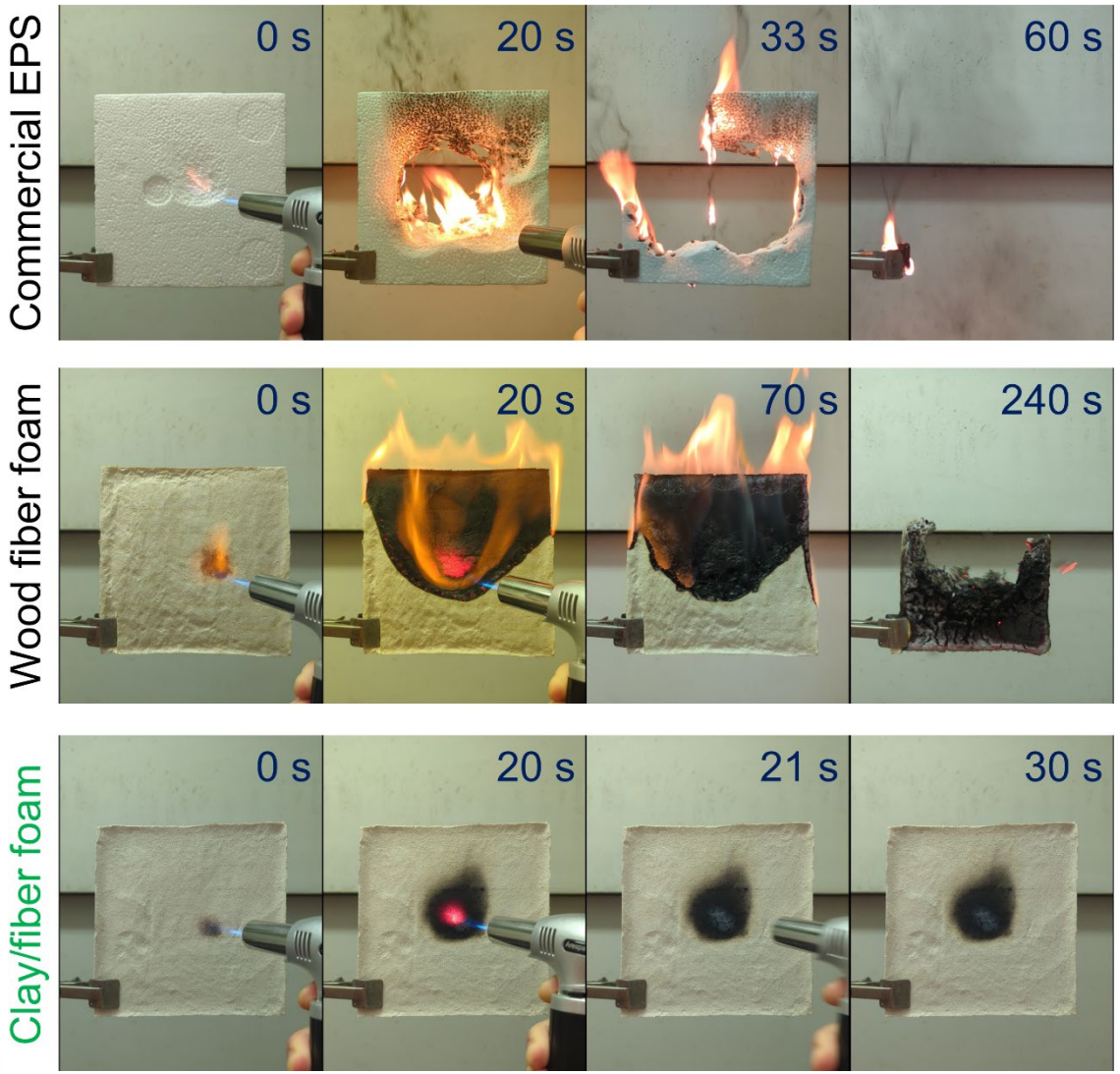
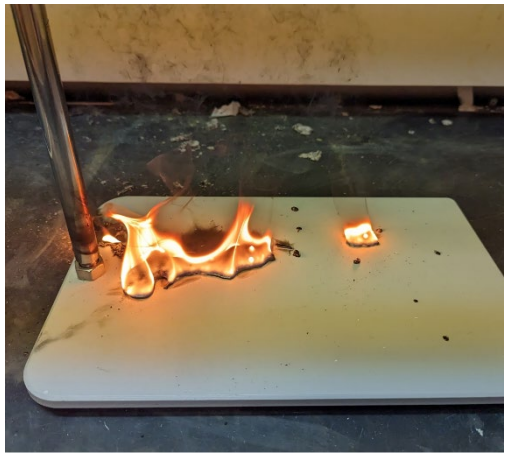
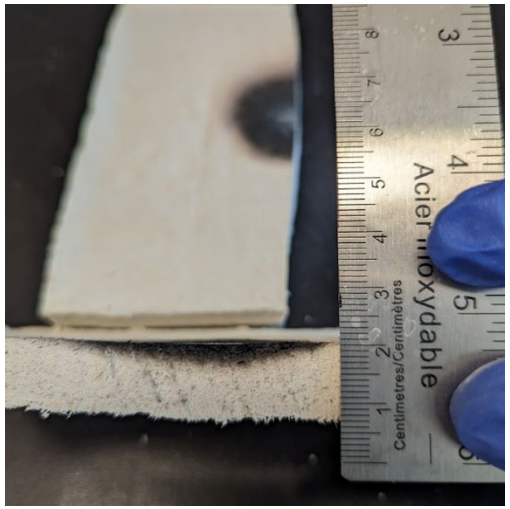
Fire retardancy







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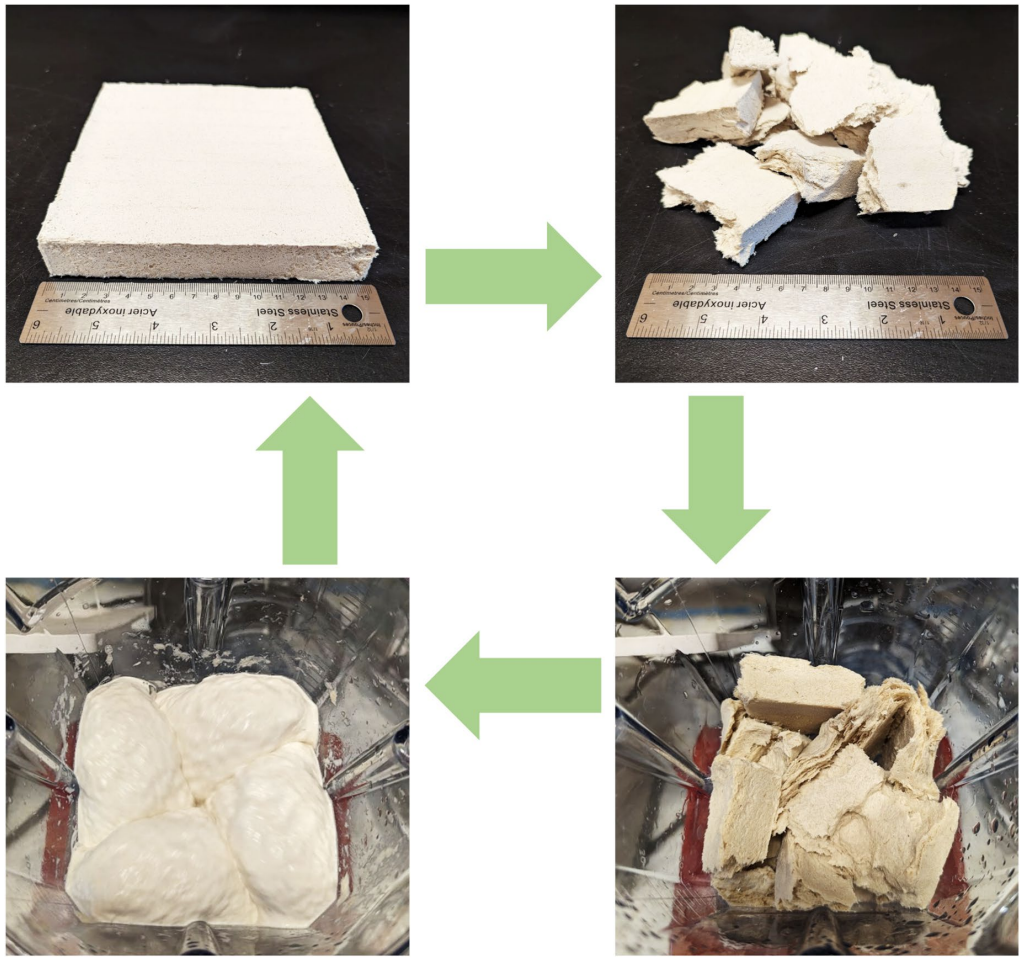
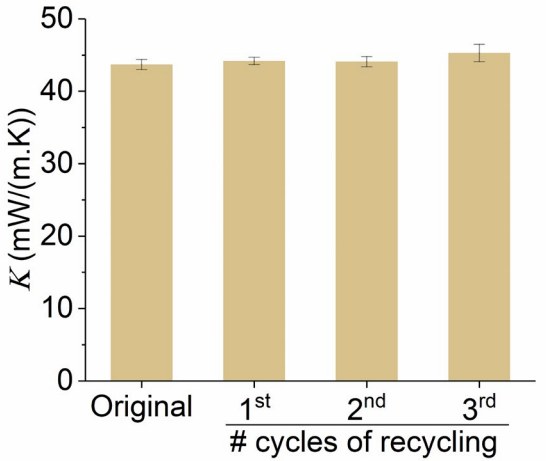
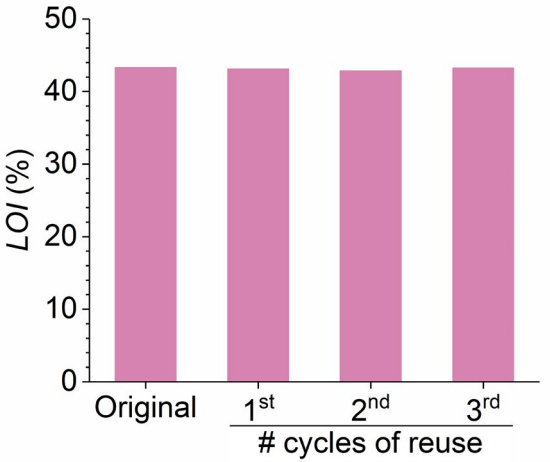
Recyclability







Manuscript submitted

Take-home messages

- Clay / lignocellulose hybrid foam
- R value: 3.3 – 4.0 /in
- Good fire retardancy
- Recyclability for circular economy

Acknowledgement

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INNOVATION
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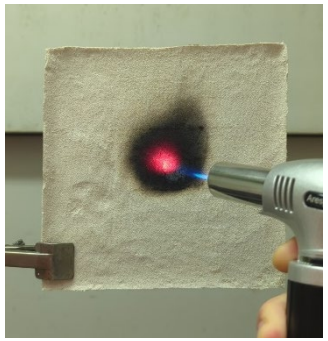
BRITISH COLUMBIA
Ministry of Forests

Forestry Innovation Investment



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