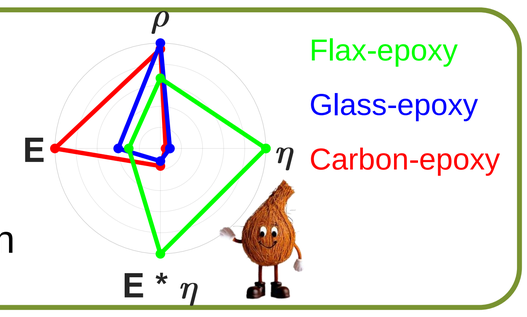
Damping dynamics: unlocking the secrets of green composites!

Context and objective

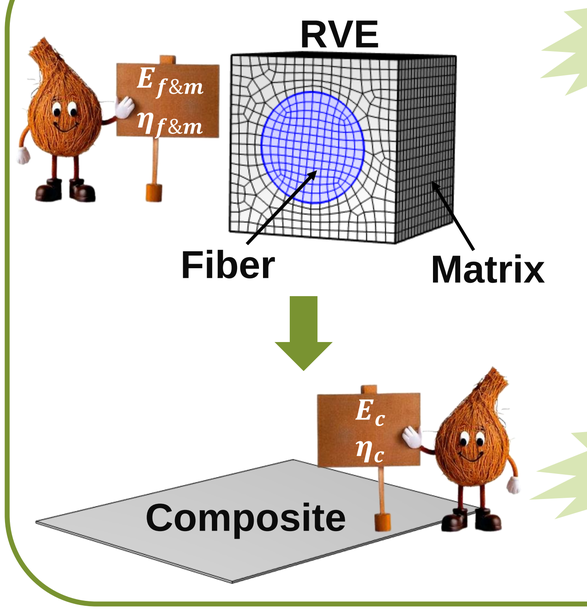
Plant-based composites: renewable, lower carbon footprint over synthetic composites

Key properties: depend on fiber type, volume fraction, orientation [1-2]

Composite stiffness/damping optimization: multi-scale modeling [3-4] and experimental validation



Numerical model



micro scale

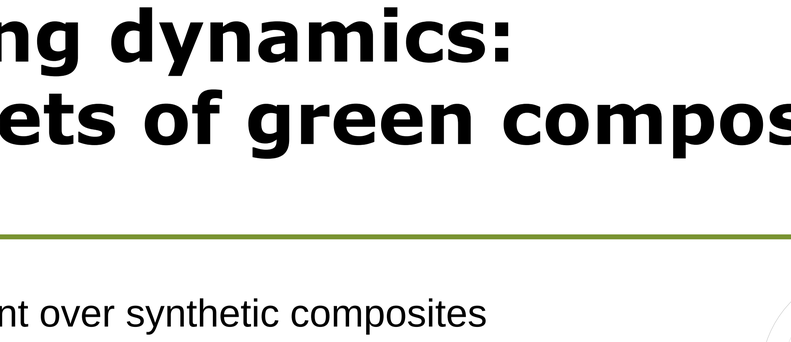
Cell periodicity study

Homogenized material property

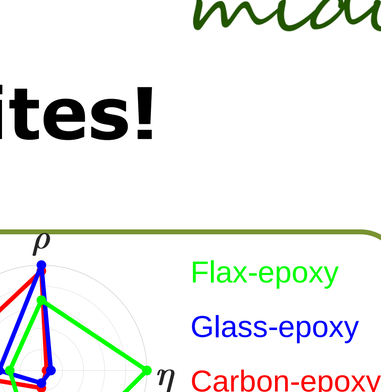
MACRO SCALE

Complex eigenfrequency study

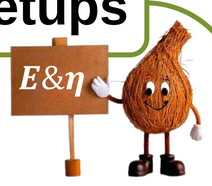
Fabrication process



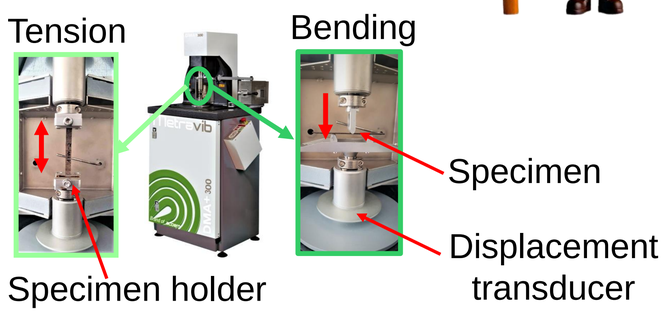
Tomography: porosity identification



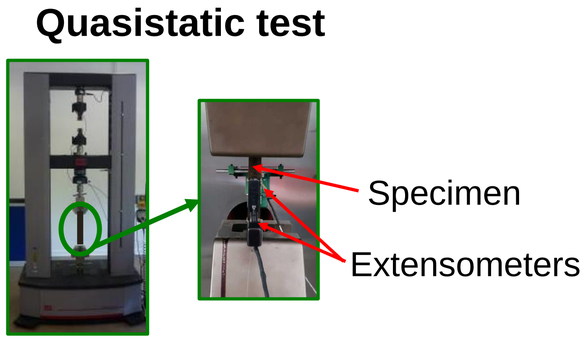
Experimental setups



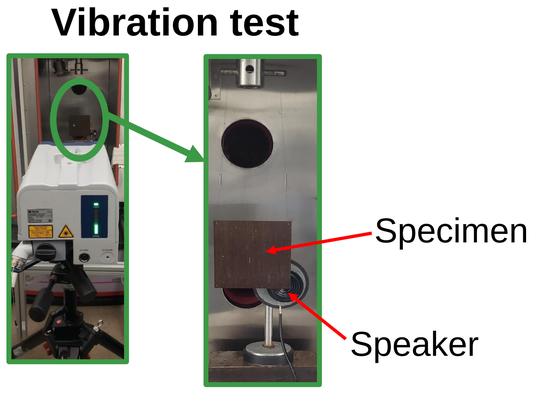
DMA test



Quasistatic test

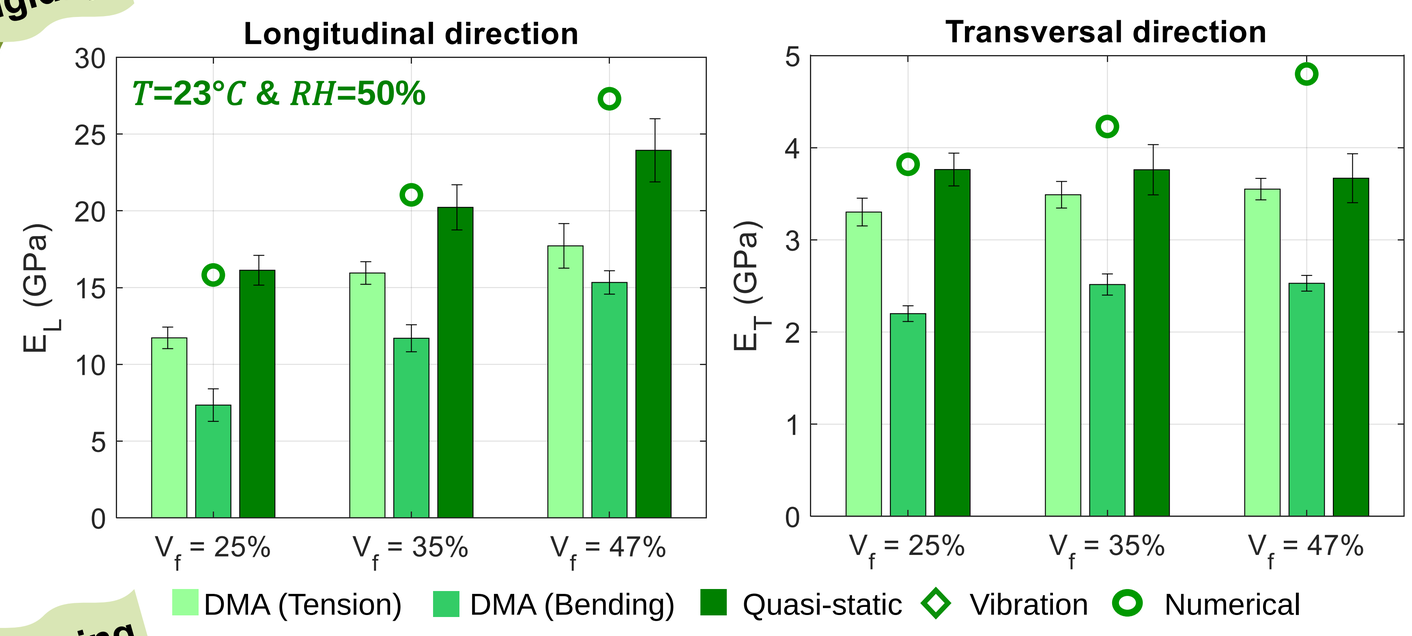


Vibration test

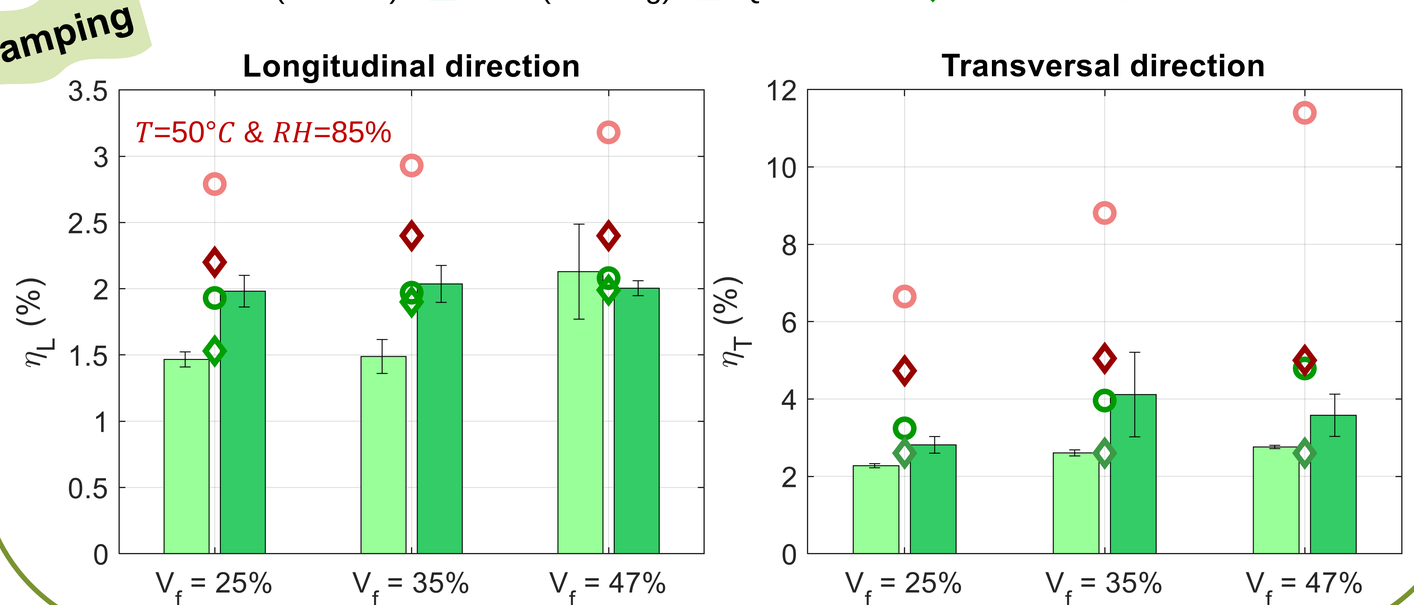


Impact of fiber volume fraction (V_f)

Rigidity



Damping

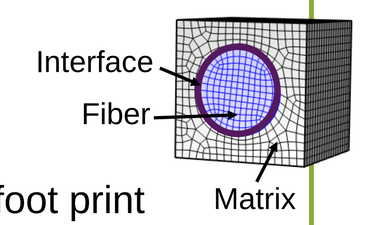


Conclusions

- As expected, ↗ V_f = ↗ E_L
- **50% *RH*** ➡ **85% *RH***: ↗ η_L, revealing moisture sensitivity
- ↗ V_f = ↗ η_L @ $T = 23°C$ & $RH = 50\%$
- Hierarchical effects (fiber, matrix, interface)

Perspectives

- Model validation: tests on conventional fibers, various matrices and varying volume fractions
- Sensitivity analysis at the constituent scale
- Optimization of damping, stiffness and carbon foot print



[1] Ming Qiu Zhang, Min Zhi Rong, and Xun Lu. Fully biodegradable natural fiber composites from renewable resources: all-plant fiber composites. Composites Science and Technology, 65(15-16):2514–2525, 2005.

[2] Liu, T. (2021). Multi-scale damping characterization of plant fiber composite materials.

[3] Devireddy, S. B. R., & Biswas, S. (2014). Effect of fiber geometry and representative volume element on elastic and thermal properties of unidirectional fiber-reinforced composites.

[4] Rezaei, A., Goroz Gómez, D., Gilabert, F., Desmet, W., & Van Paepegem, W. (2016). Micro-scale finite element simulation of the viscoelastic damping in unidirectional fiber reinforced composites.

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