Stochastic Modeling of Inter-fiber Contacts in Wood Fiber Mats

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Abstract

For the insulation of buildings, wood fiber mats are currently of high interest as they are recyclable and made from a renewable resource. However, their performance does not yet reach the one of conventional materials. The microstructure of the mats is a key influencing factor for their thermal insulation. We therefore aim to optimize the microstructure by creating digital twins for thermal conductivity simulations.
The fiber mats are highly porous (3 % - 10 % solid volume fraction) and consist of single fibers and fiber bundles, which may vary strongly in size and orientation. Hence, we construct an efficient stochastic model to generate realizations that are large enough to represent the variability in the data. Moreover, the contact between fibers is highly relevant for thermal conductivity in the solid phase. This requires us to model the interaction between fibers at a high resolution.
To this end, we employ the Altendorf-Jeulin model for systems of curved fibers. Being a parametric model, it provides us with the possibility to systematically modify parameters and study their influence on thermal conductivity. We adapt the model to contain bundles of parallel fibers. Furthermore, we extend the model such that we can efficiently calculate and increase the number of inter-fiber contacts.

References

1. H. Altendorf and D. Jeulin. Random-Walk-Based Stochastic Modeling of Three-Dimensional Fiber Systems. *Physical Review E* **83** (4), 041804, 2011.