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La soutenance a lieu publiquement

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Composition du Jury

Civilité	Nom	Prénom	Grade / Qualité	Rôle
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Résumé

Most of composite manufacturing processes require an impregnation phase of the fibrous reinforcement by a polymer matrix. The optimization of this phase is crucial to avoid defects such as porosity that can compromise the end-use properties of the parts. This is even more difficult with biosourced fibrous reinforcements. Hence, it is crucial to determine the permeability of the fibre reinforcements as a function of the process-induced evolution of their microstructure, and to control the propagation of the flow front of the polymer matrix.
Thus, we investigated experimentally and numerically the evolution of several key descriptors of the microstructure of flax fibre reinforcement materials as a function of their compaction, using 3D X-ray microtomography images. These descriptors were used in a modified Kozeny-Carman anisotropic permeability model whose predictions were in good agreement with CFD simulation results performed on the 3D images. However, one remaining unknown flow-microstructure coupling parameter needs to be identified by a numerical method. Then a new full analytical tensorial permeability model was built using the homogenisation with multiple scale asymptotic expansions. Its originality is that it accounts for variations in the fibre orientation distributions. Its relevance was assessed using permeability results obtained numerically on various virtual fibre networks as well as real fibrous materials.
3D images were also used to investigate the phenomena that occur during the propagation of a flow front in a model fibre network. For that in situ impregnation experiments were performed using ultrafast and high resolution synchrotron X-ray microtomography and a specially developed device. The variations in the fluid-air interface curvatures, triple line lengths, and local contact angles were quantified using advanced image analysis procedures. Hence, local capillary forces and capillary pressure were estimated during the flow front propagation. These original results will allow theoretical and numerical impregnation models to be improved.