

Efficient architectures to obtain high gas barrier materials using PLA and nanocellulose

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INTRODUCTION

Nanocelluloses, a major innovation in the field of the paper industry, have clear advantages for food packaging. They are bio-based, compostable, transparent materials with a high barrier to oxygen permeation. To exploit this potential, changes in barrier properties during sorption of water vapor must be controlled and their compatibility with hydrophobic polymer matrices must be optimized. To raise to these challenges, the consortium of the national French research project “ANR GASP” consortium developed new and scalable methods of compatibilizing the interfaces of nanocelluloses in hydrophobic matrices. The impact of the nanocelluloses on polylactide (PLA), a largely used polymer in packaging applications, was analysed in particular its mechanical, thermal and barrier properties. Two types of architectures of PLA/nanocellulose materials were compared, nanocomposites and multilayers with nanometric barrier layers.

RESULTS AND DISCUSSION

Nano- and microcomposites with high nanocellulose content were produced either by casting or by twin-screw extrusion. Multilayer architectures with sub-micrometric nanocellulose layers were obtained using bar coating. Nanocomposite structures, including a dispersion of compatibilized nanofillers over a wide range of nanocellulose levels, showed to be effective in protecting nanocelluloses from ambient humidity with the result of increased water vapor and oxygen barrier properties. To obtain high oxygen barriers, however, the multilayer structure was much more efficient. Using thin films, gains of an order of magnitude in gas barrier properties were obtained, but without effect on the water vapor resistance.

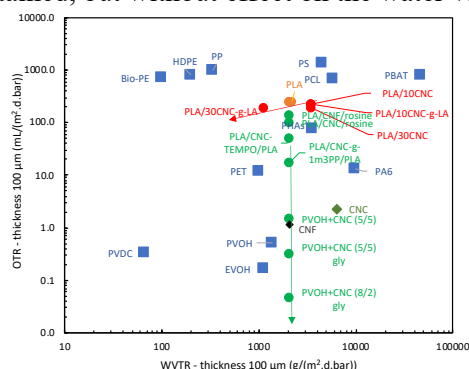


Figure 1. Barrier properties of PLA/nanocellulose materials a function of compatibilizing and architecture

CONCLUSIONS

Optimization of these structures should make it possible to use nanocelluloses in the field of food packaging.

REFERENCES

1. Le Gars, M., Bras, J., Salmi-Mani, H., et al. *Carbohydrate Polymers* **2020**, 234, 115899.
2. Le Gars, M., Roger, P., Belgacem, N., Bras, J. *Cellulose* **2020**, 27, 4319.
3. Le Gars, M., Dhuege, B., Delvart, A., Belgacem, M. N., Missoum, K., Bras, J. *Acs Omega* **2020**, 5, 22816.
4. Faraj, H., Sollogoub, C., Guinault, A., Gervais, M., Bras, J., Salmi-Mani, H., Roger, P., Le Gars, M., Domenek, S. *Materials Today Communications* **2021**, 29, 102907.
5. Htira, T., Zid S., Zinet, M., Espuche, E. *Polymers* **2021**, 13 (16), AN: 2615
6. Faraj, H., Follain, et al. *Polymer Testing* **2022**, 113, 107683