Uniaxial high pressure thermocompression of cellulosic and lignocellulosic materials

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All-cellulose materials were prepared by low moisture and high temperature uniaxial high pressure thermocompression of α-cellulose. Among all tested conditions, best results were obtained at 2%MC and 250°C[1]. These specimens were orthotropic showing better properties in bending than in tension and revealed a very specific morphology with a more porous heart, a dense but very thin skin on the faces (orthogonal to the compression axis) and thick and extremely dense sides. During the process, the pressure increase involves a severe friction between the fibers resulting in a decrease of cellulose molecular weight while temperature allows to get above cellulose glass transition and is responsible for the migration of water towards the heart of the piece. At a temperature around 200°C it accumulates and provokes delamination when pressure is released but, at higher temperature, water, in a subcritical state, may be consumed during the hydrolysis of the amorphous part of cellulose. Regarding cohesion, most of it comes from the small sides of the test samples (parallel to the compression axis) and seemed to be mainly related to the entanglement of amorphized cellulose at the interface between the particles.

The same process was then applied to various lignocellulosic materials and the influence of their composition and morphology on their mechanical and water-resistance properties was statistically analyzed[2]. Cellulose and lignin contents were, as expected, the most important factors.

Finally the possibility of a chemical grafting during the compression was proved while using only green chemicals (i.e. fatty acid and/or fatty anhydride)[3]. Low degrees of substitution were achieved, they were sufficient to greatly improve the water resistance properties of the specimens but were also responsible for a marked decrease of their mechanical properties. This procedure still needs to be improved to produce in a one-step process hydrophobic materials.

1. Pintiaux T., Heuls M., VanDenBossche V. , Gaboriau M., Castignolles P., Rouilly A, Cellulose, **2017**, submitted.
2. Pintiaux T., *PhD Thesis INPT*, **2015**.
3. Pintiaux, T., Laourine, F., Vacamedina, G., Rouilly, A., Peydecastaing, J., *BioResources,* **2015,** 4626–4640 (2015).