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Chemical modification of cellulose-rich fibres to clarify the influence of the chemical structure on the physical and mechanical properties of cellulose fibres and thereof made sheets.

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Highlights:

- Surface modification to provide different functional groups.
- An amorphous shell of modified cellulose surrounds the crystalline cellulose.
- Relation between chemical structure and performance of handsheets.
- The performance of the materials is determined by the functional groups.

Abstract

Despite the different chemical approaches used earlier to increase the ductility of fibre-based materials, it has not been possible to link the chemical modification to their mechanical performance. In this study, cellulose fibres have been modified by periodate oxidation, alone or followed either by borohydride reduction, reductive amination or chlorite oxidation. In addition, TEMPO oxidation, and TEMPO oxidation in combination with periodate oxidation and further reduction with sodium borohydride have also been studied. The objective was to gain understanding of the influence of different functional groups on the mechanical and structural properties of handsheets made from the modified fibres. It was found that the modifications studied improved the tensile strength of the fibres to different extents, but that only periodate oxidation followed by borohydride reduction provided more ductile fibre materials. Changes in density, water-holding capacity and mechanical performance were also quantified and all are dependent on the functional group introduced.

Keywords: Cellulose fibres, borohydride reduction, chemical modification, chlorite oxidation, periodate oxidation, TEMPO oxidation, structure-property relationship.

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