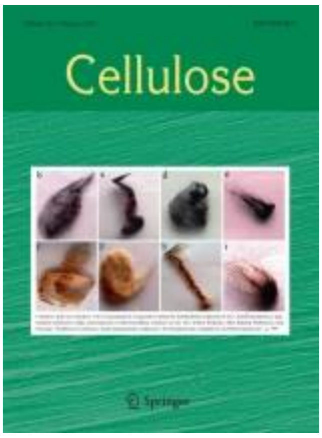
Mechanical and softness characterization of “deco” and “micro” embossed tissue papers using finite element model (FEM) validation



Joana Costa Vieira, Flávia Morais, António de Oliveira Mendes, Marcelo Leite Ribeiro, Ana Margarida Carta, Joana Curto, Maria Emília Amaral, Paulo Torrão Fiadeiro & Ana Paula Costa

Cellulose - Volume 29, pages 5895–5912
DOI: 10.1007/s10570-022-04618-2
Publication Date (Web): May 22, 2022

Abstract

An innovative approach of using a laboratory embossing prototype was carried out to develop and optimize tissue papers, to quantify the influence of “deco” and “micro” embossing. A comparison between non-embossed and embossed tissue papers was conducted to investigate the effect of this process, on industrial and laboratory-made structures, evaluated by mechanical and softness properties. To identify the influence of the embossing patterns, the fiber composition and the creping process, a creped industrial base tissue paper, a disintegrated fibrous suspension obtained from this one, and an industrial never-dried bleached eucalyptus kraft pulp, were used as samples. These last two materials were used to produce similar industrial base tissue paper, in other words, handsheets with a grammage of 17 g/m2 and unpressed. The end-use tissue properties were evaluated on the non-embossed and embossed structures. The results indicated that the embossing process produced bulkier and more porous structures, at the expense of reduced mechanical and softness properties, more intensified in the “micro” embossing than in the “deco” embossing. The effect of fiber composition shows that the mechanical properties were increased with an adverse effect on the structures' TSA-softness. Furthermore, these properties are enhanced for the structures where creping process effects are presents. The performance of structures with and without embossing allowed to quantify the functional properties of softness and strength, combining ISO experimental methods and computational approaches that benefit from modeling strategies considering its structural hierarchy at the fiber and structure levels, and the shape pattern used in the embossing process. Finite Element Model (FEM) analysis enabled a better understanding of how the embossing patterns affect the mechanical properties during the embossing process. The experimental results were validated using FEM simulation, which proved that

“micro” pattern has a higher stress field value, and consequently a lower mechanical strength. Overall, the results indicate that the embossing prototype can be used as an opportunity to investigate the embossing process at laboratory scale and to optimize the final end-use tissue properties due to the controlled process parameters implemented in this methodology.