Wood nanocellulose is a novel biomaterial for wound dressing applications. Nanocellulose can be manufactured using various pre-treatments, which facilitate the effective fibrillation from micrometre-sized cellulose fibres to nanofibrils. In addition to facilitating the fibrillation of cellulose fibres, chemical pre-treatments modify the surface chemistry of cellulose nanofibrils, which can be applied for functionalization purposes [1]. The purpose of this work was to quantify the morphology of nanocellulose surfaces by applying various complementary microscopy techniques. In addition, the colonisation of the nanocellulose surfaces with bacteria was assessed in detail.

Wood nanocellulose was produced from never-dried P. radiata pulp fibres. The applied pre-treatment was 2,2,6,6-tetramethylpiperidinyl-1-oxyl (TEMPO) mediated oxidation. To characterise bacterial growth, P. aeruginosa PAO1 biofilms were grown in Mueller Hinton broth (37°C for 24-48h) on air-dried films. Various microscopy techniques, including atomic force microscopy (AFM), confocal laser scanning microscopy (CLSM) and field-emission scanning electron microscopy (FESEM), were applied to characterise the nanocellulose material and the bacterial-nanocellulose interactions [2]-[4]. The FESEM analysis was performed on areas without metallic coating, applying the capabilities of in-lens detectors. The images were thus acquired with low acceleration voltage (<1 kV) and short working distance (<1mm).

Multiscale assessments, including FESEM and AFM, revealed the effective fibrillation of the fibre wall structure, yielding nanofibrils with diameters less than 20 nm and lengths in the micrometre-scale (Figure 1). Importantly, we have demonstrated that the growth of PAO1 was inhibited in the presence of the nanocellulose suspensions when compared to the control. Additionally, SEM imaging revealed distinct clusters of PAO1 cells growing on the surfaces of nanocellulose films (Figure 2). This work highlights the potential usefulness of novel nanocellulose materials in wound dressings with optimized characteristics.

[1] K. Syverud et al., Nanoscale research letters 6 (2011) 626

Acknowledgement: This work has been funded by the Research Council of Norway through the NANO2021 program, grant no. 219733 – NanoHeal: Bio-compatible cellulose nanostructures for advanced wound healing applications.
Fig. 1: FESEM of the surface of a P. radiata kraft pulp fibre.

Fig. 2: FESEM of the surface of a nanocellulose film composed of individualized cellulose nanofibrils.

Fig. 3: SEM imaging of P. aeruginosa PAO1 grown on nanocellulose surfaces for 24 h.