ABSTRACTS (MASTER THESIS)

Functionalization of cellulose nanofiber sheet surface by imprinting method

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Introduction

Water repellence generated by hierarchical surface structures is known as the “Lotus effect”. In this study, hierarchical structures were formed on cellulose nanofiber (CNF) sheet surfaces by copying a micro-pattern on a silicon wafer onto a CNF sheet. The water repellent performance was studied.

Experiments and results

A silicon wafer template (pattern: $\varphi = 4$ μm, depth = 1 μm, for each 12 μm) was pressed on wet mats of TEMPO-oxidized CNFs swollen with different organic solvents. The mat was dried slowly (Fig. 1). The surface structure of the sheet was observed by FE-SEM and the specific surface area and wettability of the sheet were evaluated.

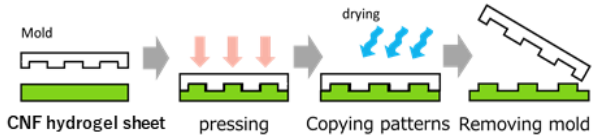

Fig. 1 the procedure of making hierarchical roughness on CNF seats

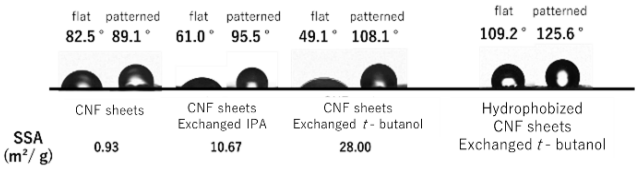

Fig. 2 the result of measurement of contact angles

Fibrous CNF pillars were successfully formed on the surface of the CNF sheet. For a smooth surface, the contact angle of a water droplet on the CNF sheet decreased sharply with increasing specific surface area. This is explained by Wenzel’s formula[1]. In contrast, the contact angle of a CNF sheet with a hierarchical structured pattern increased considerably (Fig. 2), although CNFs are strongly hydrophilic. It is plausible that this is because for the hierarchical surface structure with micro-pillars, water droplets contact not only the CNFs but also the air between the CNF pillars.

On the basis of these results, hydrophobized TEMPO-oxidized CNFs were prepared using tetra-4-butylammonium hydroxide[2] and their water repellent performance was studied. Compared with that of native CNFs, the contact angle of the hydrophobized sheets increased in the cases of both smooth and patterned surface sheets. In particular, the contact angles of surface-patterned hydrophobized CNF sheets increased significantly with increasing surface area and reached a contact angle of 125.6°. The molding strategy developed in this study can be regarded as a simple form of micro- and nano-imprinting lithography techniques. The results of this study will enable the production of unique filters and separators.

Acknowledgements

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References

[1] Wenzel R. N., Industrial and Engineering Chemistry, 1936, 28, 988-994.

[2] Shimizu M., *et al*. *Biomacromolecules*, 2014, 15(11), 4320-4325.