

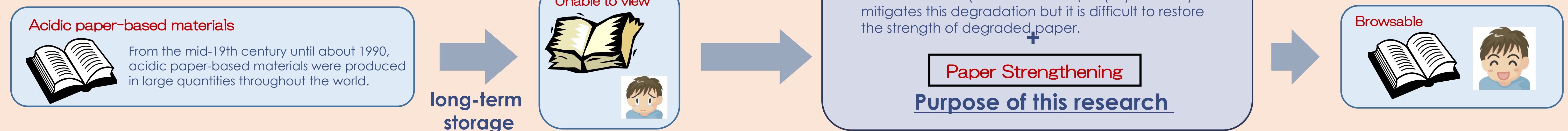
A New Technique for Strengthening of Naturally Degraded Acidic Paper with Cellulose Fibers Coating

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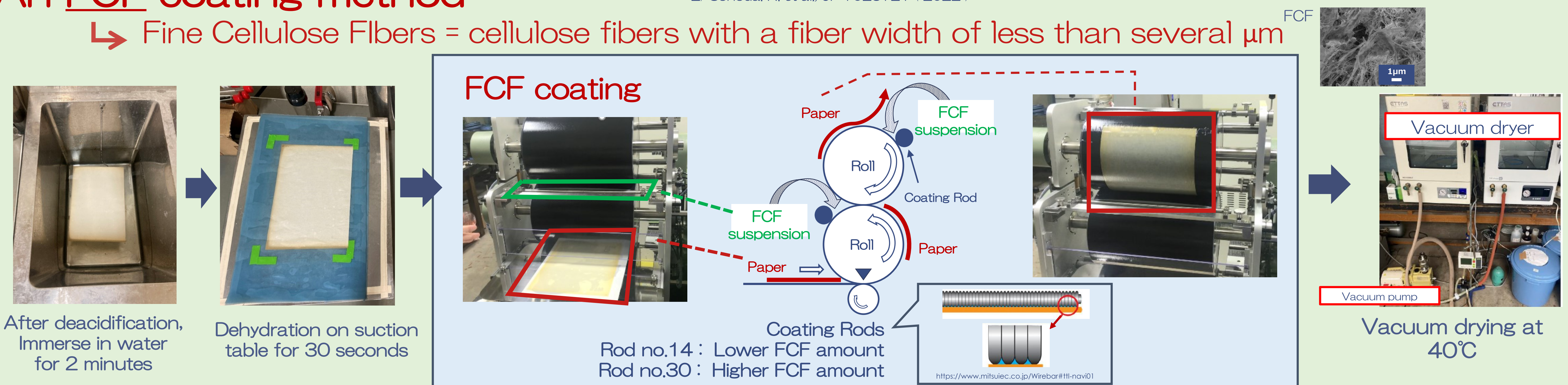
Introduction : Deacidification and Strengthening



An FCF coating method^{1,2)}

↳ Fine Cellulose Fibers = cellulose fibers with a fiber width of less than several μm

1) Okayama, T. *et al.*, XIVth Congress of International Association of Book and Paper Conservators, Warsaw (2019)
2) Sonoda, N. *et al.*, JP 7025721 (2022)



Effect of the coating treatment on the properties of the paper

Experiment

Naturally degraded acidic paper (based paper)

Commercial wood-free paper manufactured in 1981 that has naturally deteriorated (Cold water extraction pH : 5.3)

Deacidification = Bookkeeper (BK) method
treated by KIHARA Preservation Inc. in Japan

BK treated paper

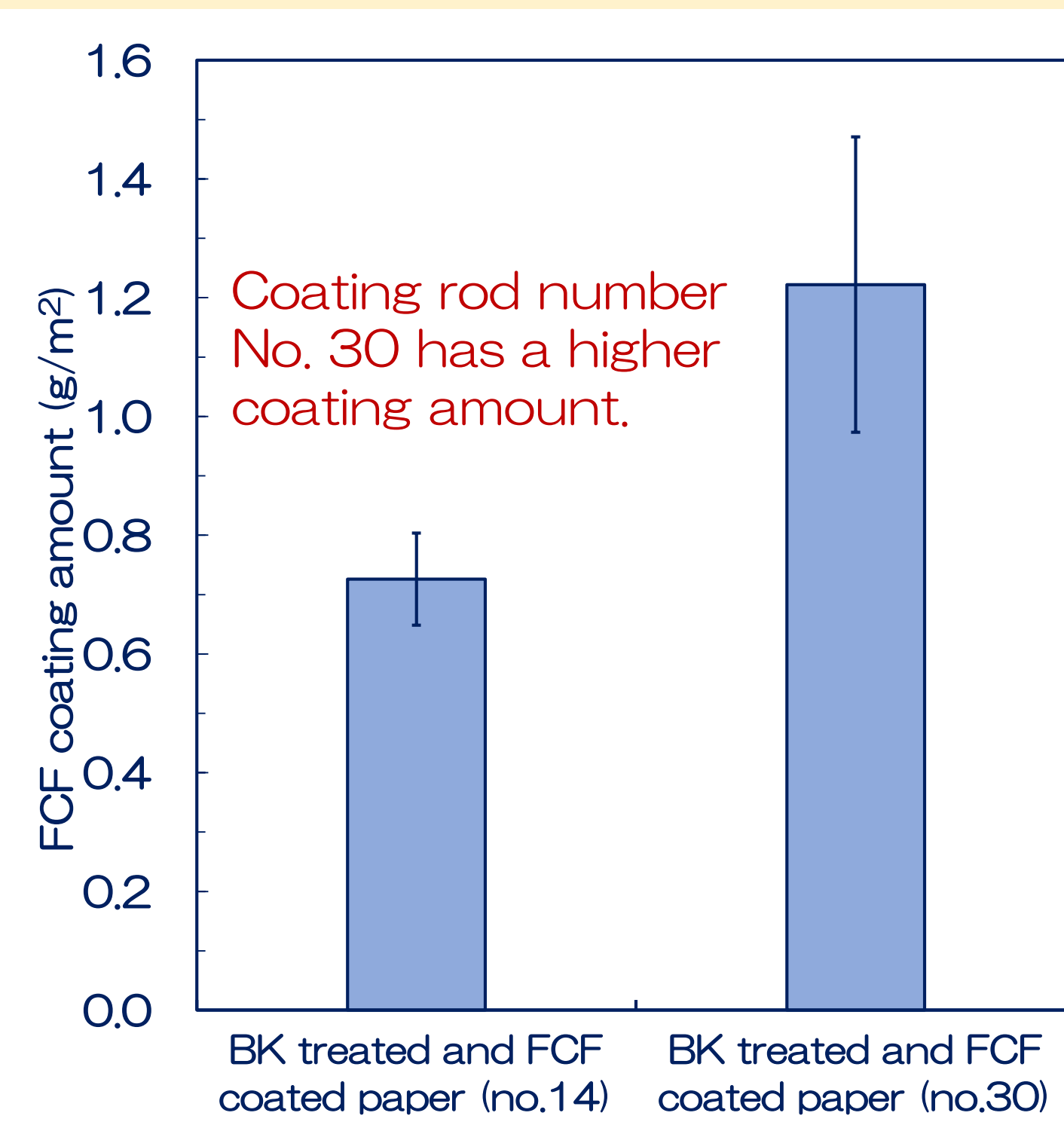
(Cold water extraction pH : 9.1, Alkali reserve : 1.72%)

Fine cellulose fibers (FCF) coating

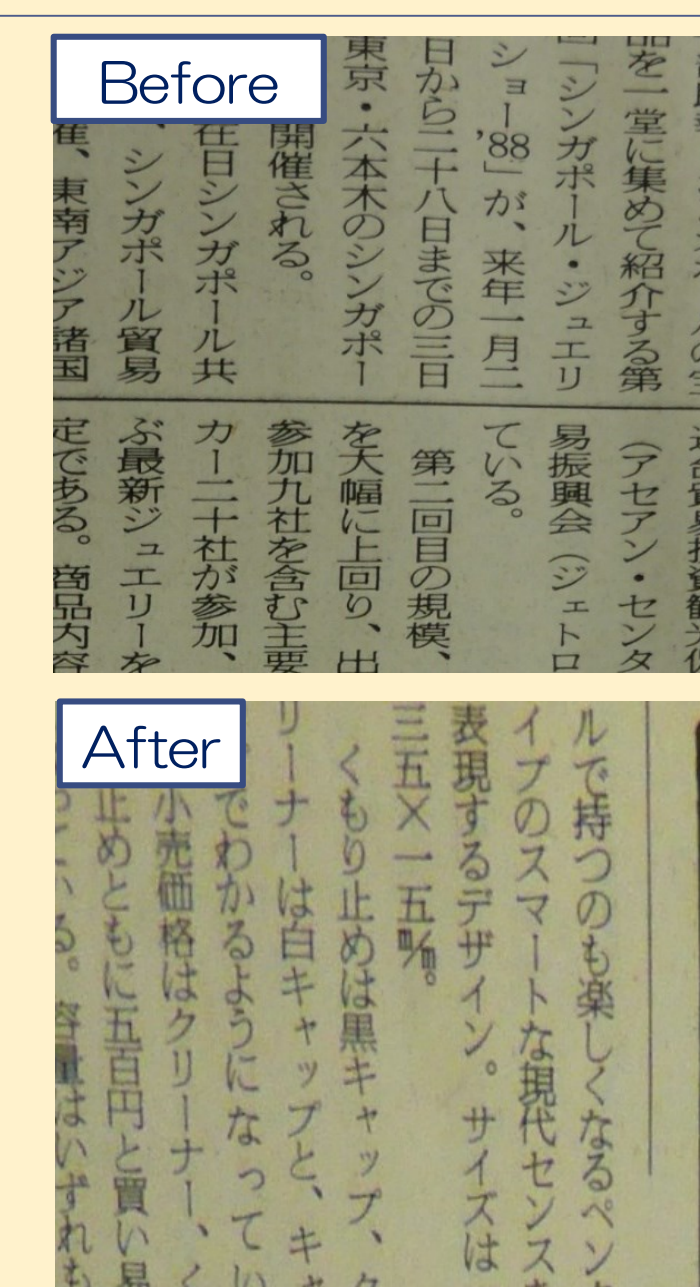
Commercial biomass nanofibers manufactured by Sugino Machine Co. in Japan, Commercial name: BinNF-i-s

FCF-coated paper

FCF coating amount on the paper by the compact coating machine

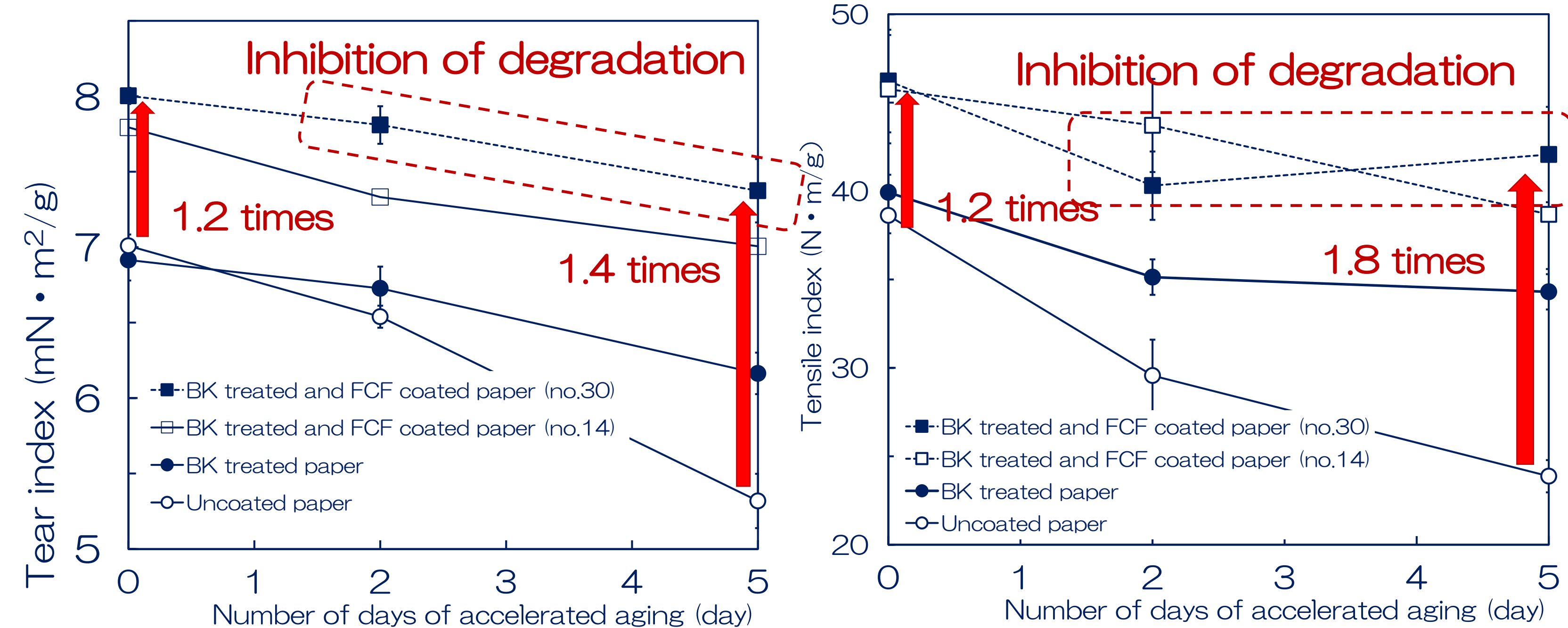


Appearance of newsprint before and after FCF coating

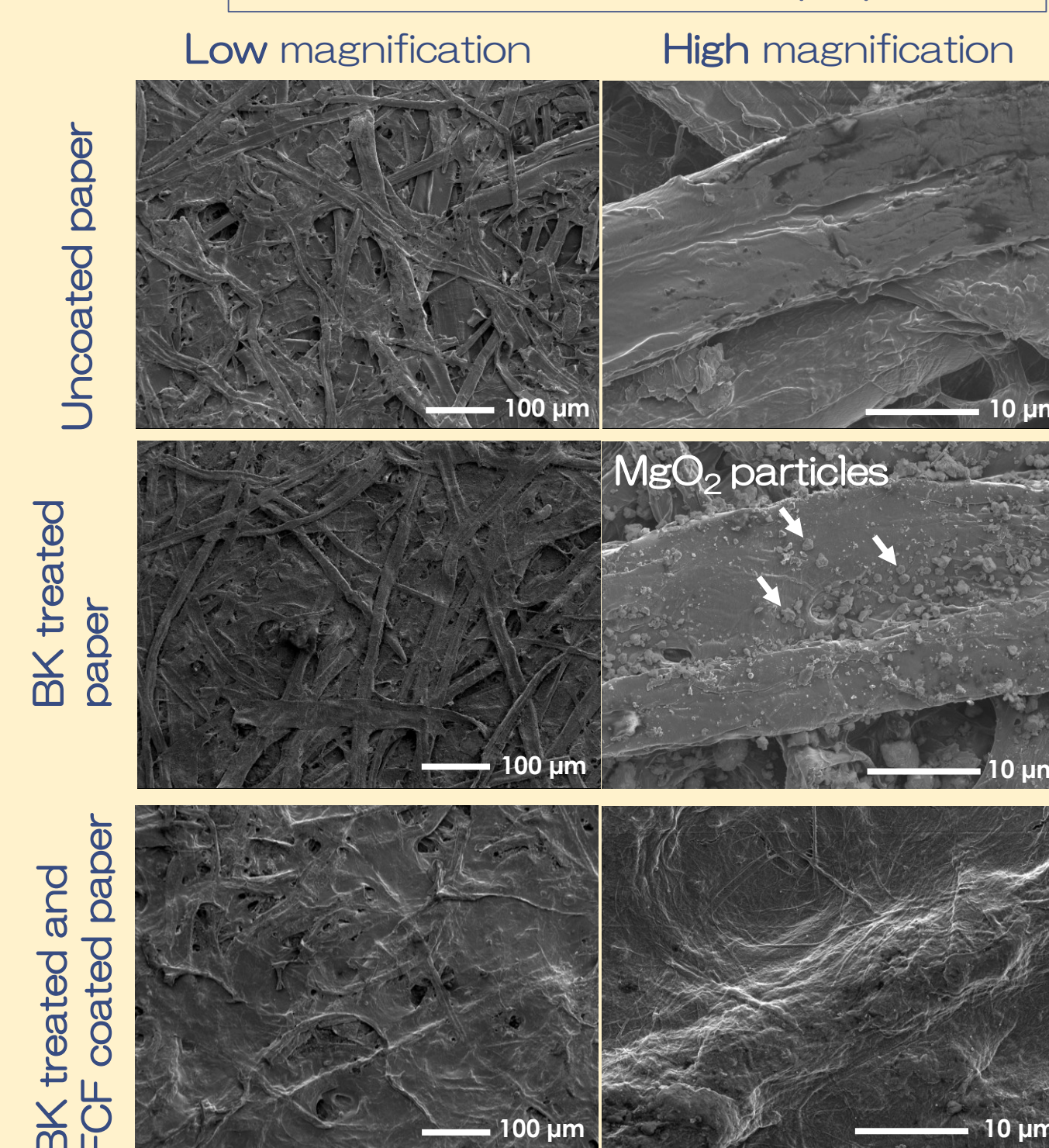


The legibility of the original paper remained unchanged after the FCF coating treatment.

Effect of FCF Coating on Tear and Tensile indexes of BK-treated Paper



The surface of the papers



Pulp fibers are covered with FCF.

Preliminary study of drying methods

Experiment

Coating FCF manually using a bar coater and drying the paper by three types of drying method

Results

Uncoated paper

FCF coated paper after drying at 105°C

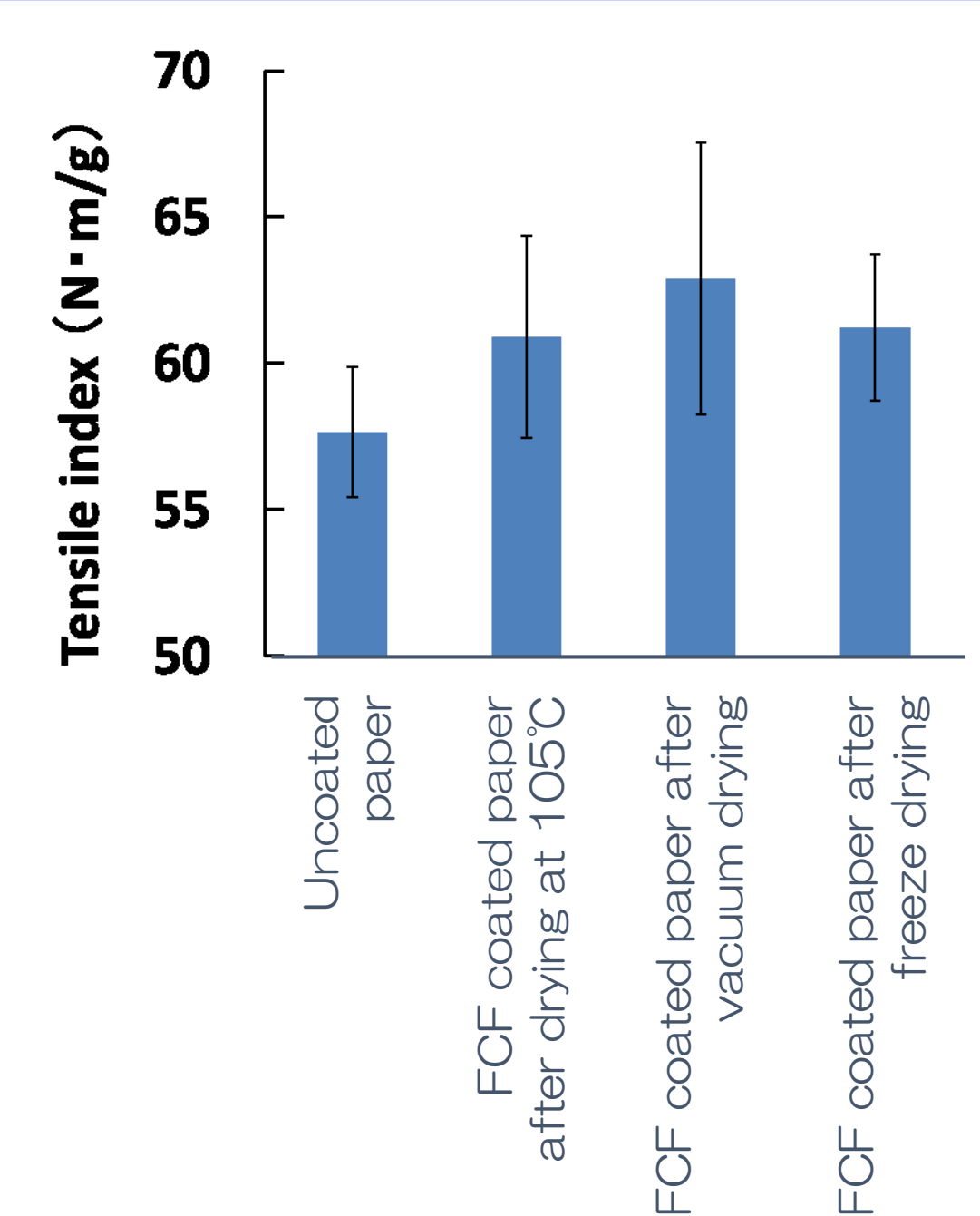
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FCF coated paper after vacuum drying

FCF coated paper after freeze drying

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Best method



Conclusions

A compact coating machine that enables a continuous coating process of fine cellulose fiber (FCF) on both sides of naturally degraded acidic paper was developed. Using the machine, the effects of FCF coating conditions on the physical properties of the paper after FCF coating were investigated.

● A uniform FCF coating layer is formed on the surface of the base paper, enabling a highly reproducible FCF coating process.

● FCF coating on naturally degraded acidic paper that had been deacidified by the BK method improved the paper's tear index. In addition, the decrease in tear index of the paper during accelerated aging test was suppressed.

● For the degraded wood-free paper coated with 1.22 g/m² of FCF, tear index of the FCF-coated paper deacidified by the BK process showed approximately 1.4 times that of the uncoated paper. It was clarified that when the FCF coating process was applied to naturally degraded acidic paper, not only the tear index of the paper but also the tensile index was improved by increasing the amount of FCF coating. The FCF-coated deacidified papers have been proven to present long-term stability during accelerated aging test.