Remoistenable Nanocellulose Film: Practical Application and Analysis

Robin Canham, Department of Art History and Art Conservation
Queen's University, Kingston, Ontario, Canada
robin.canham@queensu.ca

Introduction

Microfibrillated cellulose (MFC), commonly referred to as nanocellulose, is an emerging material in paper conservation treatment. However, the practical use of nanocellulose film with water-based adhesives can be problematic. Challenges include:

- loss of stability and disassociation of the film; and
- planar deformation.

In published treatments to date, only ethanol-based adhesives have been used with nanocellulose film.

Therefore, this research aims to:

- characterize and describe nanocellulose film;
- understand the working properties of nanocellulose film as compared to Japanese tissue through expansion and shrinkage tests; and
- investigate techniques to create remoistenable nanocellulose film with a variety of adhesives.

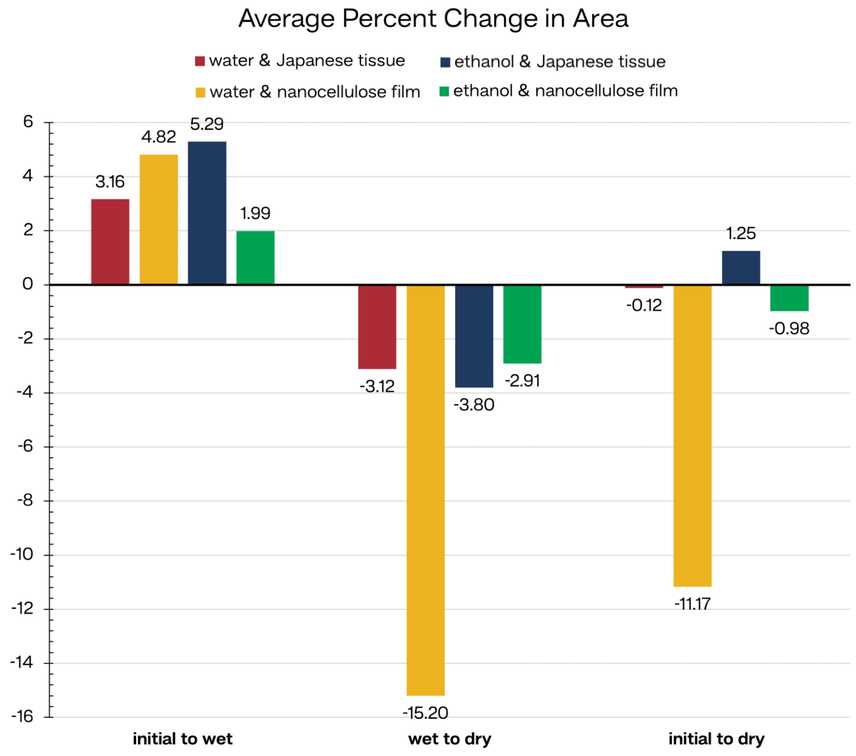
Experimental

I. Nanocellulose film was prepared according to cited references.
II. The film was characterized using a variety of methods. Colour, gloss, texture, thickness, weight (GSM), fibre morphology, and cost were examined.
III. Expansion and shrinking tests were conducted on the nanocellulose film (6.399 g/m^2) and Japanese Tengu-jo tissue (5 g/m^2). Distilled water and ethanol were selected as wetting agents.
IV. Remoistenable nanocellulose film was created using six adhesives (Table 1). Four were water-based and two were ethanol-based. Progressive refinement of technique over three rounds of qualitative analysis were conducted.

Three prepared sheets of nanocellulose film (14.0 cm in diameter). The thickness of each film was approx. 0.0145 mm or 14.5µm.

Results and Discussion

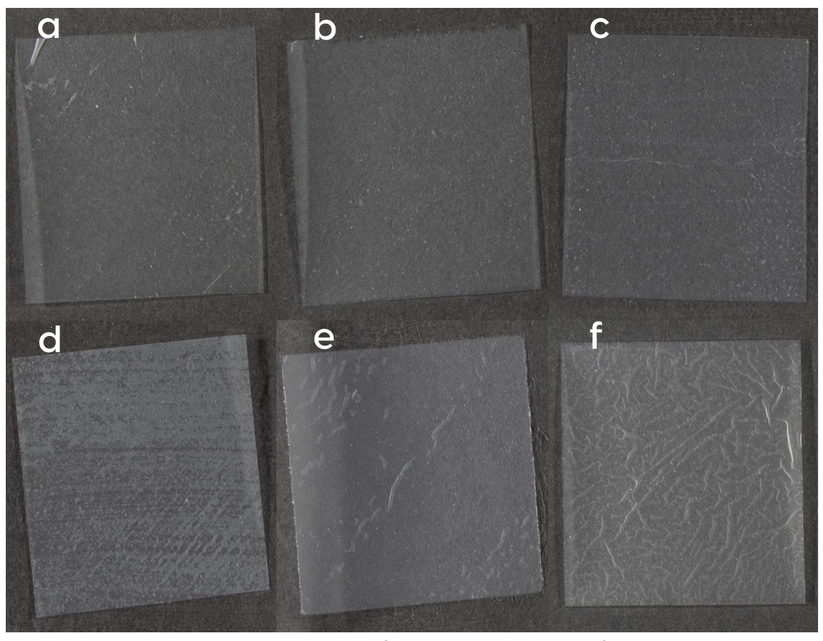
Expansion and Shrinking Tests



From initial to dry, Japanese tissue and water exhibited the least net change in area (-0.12%). This suggests that while Japanese tissue expanded when wet, it dried to its approximate initial size.

When water was introduced to nanocellulose film, the film shrunk approximately 11% in area from initial to dry. When ethanol was introduced, the film shrunk approximately 1%. These results correspond to observations that water-based adhesives cause more planar deformation than ethanol-based adhesives when used with nanocellulose film.

Remoistenable Film



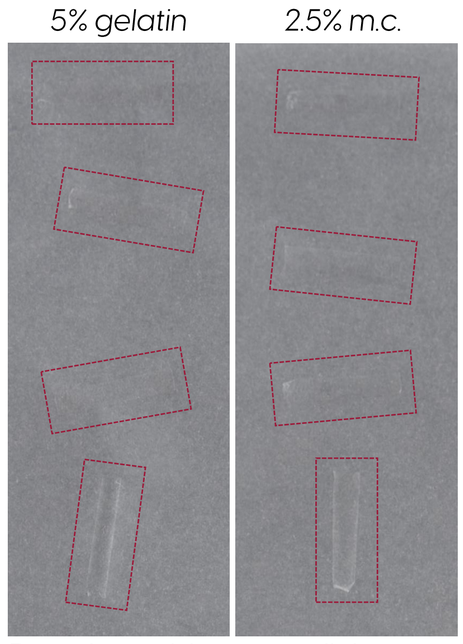
Natural light photographs of remoistenable film, placed on a grey background to illustrate uniformity and texture. The best sample for each application is presented.

Table 1: Adhesive Applications
a. 5% gelatin on Mylar
b. 2.5% Methocel A4M methylcellulose on Mylar
c. 50:50 mix of 2.5% Methocel A4M methylcellulose and wheat starch paste on Mylar
d. wheat starch paste on Mylar
e. 10% Aquazol 200 in ethanol on Mylar
f. 5% Klucel G in ethanol on silicone-coated polyester

Various methods to create remoistenable nanocellulose film were explored. The most successful method found used a high-density foam brush to spread adhesive over Mylar. A square of nanocellulose (4.75 cm^2) was then placed on top of the adhesive layer and left to dry completely.

Applying adhesive on top of the nanocellulose film did not produce usable samples.

A damp blotter was used to reactivate the adhesive and adhere test strips to tracing paper and silver gelatin photographs.



Remoistenable nanocellulose film applied to tracing paper. Photographed in natural light on a grey background.

Conclusion

Through expansion and shrinking tests, it was found that nanocellulose film behaved noticeably different than Japanese tissue when water was introduced. Nanocellulose film shrinks significantly as it dries.

It is possible to create remoistenable nanocellulose film with good working properties. Gelatin and methylcellulose produced films with good characteristics for use in paper conservation. The ethanol-based adhesives, Klucel G and Aquazol 200, produced unsuitable films.

Continued research into adhesive concentrations, reactivation methods, repair strength, and potential transparency change is recommended.

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References

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