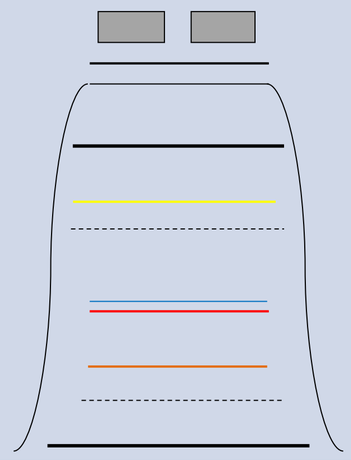
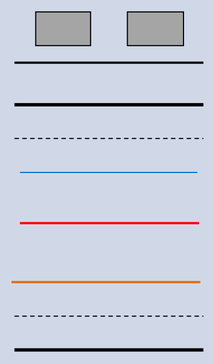
A Comparative Study of the Direct Application versus Solvent Reactivation of Klucel G

Jessica Régimbald
Art Conservation Program, Queen's University

Introduction

Abstract
Since it was first introduced to the conservation field, hydroxypropyl cellulose (HPC) has been of interest to conservators and conservation scientists alike. Today, the most used HPC is Klucel G, most often employed through direct application, but it is also used through solvent reactivation. The goal of this research project is to quantitatively determine the differences between these two application techniques using Klucel G. The strength of the adhesion will be tested using an Instron tensile test machine for the lap joint shear strength test and the T-peel test. The flexibility of the adhesion will be tested using a Taber-type tester to determine if one method of application forms a more flexible bond. Finally, the diffusion of the adhesive into the substrate will be tested using reflected light microscopy to speculate on the reversibility of the treatment. This research will be useful when making treatment decision.

Solvent Reactivation	Direct Application
 Weight / Glass / Mylar / Blotter soaked with ethanol / Gortex / Hollytex / Lining paper with dried Klucel G / Object / Hollytex / Blotter	 Weight / Glass / Blotter / Hollytex / Lining paper / 8% Klucel G solution in ethanol / Object / Hollytex / Blotter

Materials and Sample preparation

- All specimens were prepared using pure Japanese kozo unbleached paper.
- The appropriate concentration of Klucel G was based on past experience, consultation with professionals and preliminary testing. A solution of 8% Klucel G in ethanol was used for every stage of testing.
- The solvent reactivated specimens were reactivated for a period of 30 minutes.
- The direct application technique refers to the application of the adhesive on the substrate and immediately placed it under weight to set, (see above).

Experiment

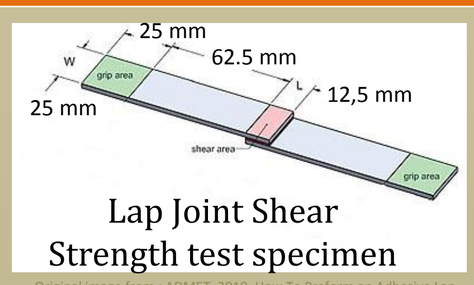
Flexibility

Taber tester loaned by Dupont.

7 cm X 4 cm specimens were set in the Taber tester and deflection at 15° to the right and the left using the 10-100 range.
After, the specimens weight was measured using an analytical balance.

Adhesion Testing

Lap Joint Shear Strength Test

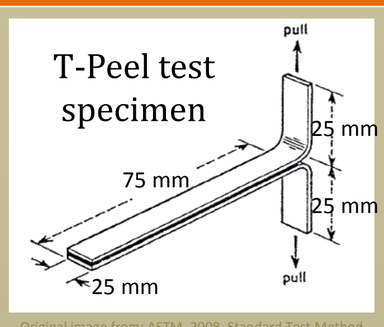


Lap Joint Shear Strength test specimen

Original image from : ADMET. 2010. How To Preform an Adhesive Lap Joint Shear Strenght Test – ASTM D1002

Test specimens were set in an Instron tensile test machine and put under stress until catastrophic failure occurred.

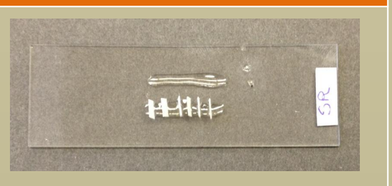
T-Peel Test



Original image from: ASTM. 2008. Standard Test Method for Peel Resistance of Adhesives (T-Peel Test), D1876 – 08

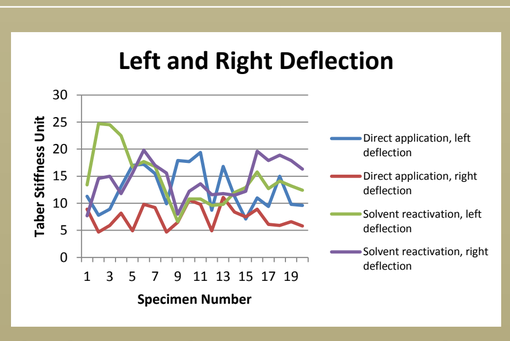
The test specimens were set in the Instron tensile test machine to determine the average force necessary to separate the supports.

Diffusion

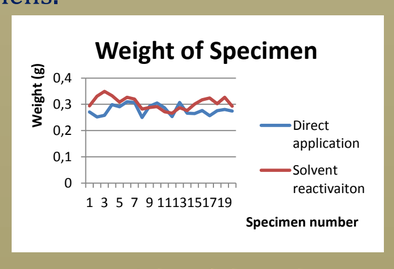


Cross sections were done by cutting 3 mm X 3 mm squares from larger specimens. These were then adhered to a slide using Cargille liquid and observed using reflected light microscopy.

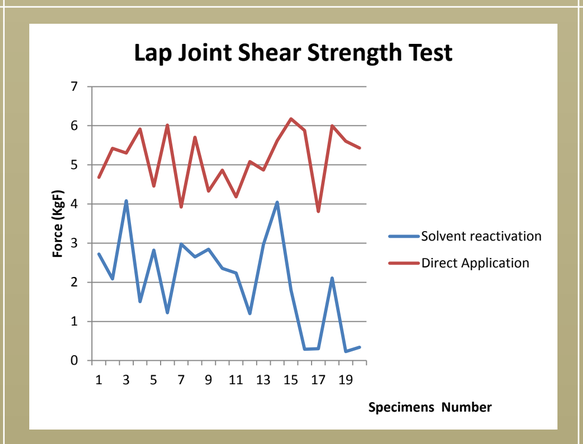
Results



○The direct application specimens showed more flexibility than the solvent reactivated specimens.

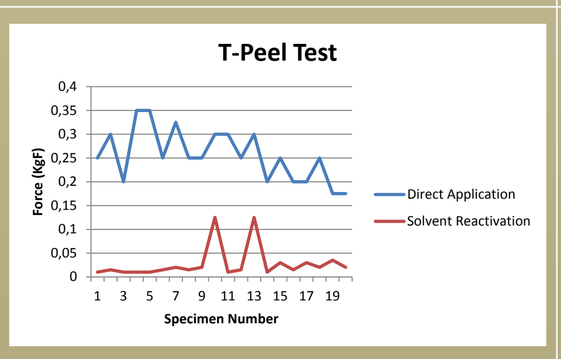


○The average weight of the solvent reactivated specimens was superior to the weight of the direct application specimens.



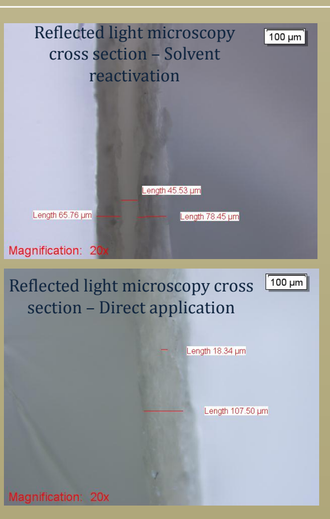
○The force necessary to obtain a critical failure in the direct application specimens was consistently greater than the force used for the solvent reactivated specimens.

○The direct application specimens all failed in the paper support as compared to the solvent reactivated specimens that mostly failed at the joint.



○The force necessary to separate the specimens was constantly higher for the direct application method.

○In the direct application specimens, the separation occurred in the paper support and not at the joint, as was the case for the solvent reactivated specimens.



The solvent reactivation cross-section displays a clear layer of adhesive whereas the direct application specimens shows multiple pockets of adhesive contained in the paper at different depths of both paper layers.

Conclusion

The direct application technique gives, for the parameters tested, a much stronger adhesion. This can be related to the greater diffusion of the adhesive in the paper support. The bond created is so strong, it can withstand a force capable of causing critical failure in an unaged pure kozo Japanese paper. Finally, it is possible to observe a variation in flexibility between the two methods of adhesion. This can be correlated to the variation in the weight of the sample due to the loss of adhesive in the direct application method once it sets under weights. To obtain a better adhesion using solvent reactivation in paper conservation, it would be interesting to investigate other reactivation techniques, vary the time of reactivation and try different solvents.

This research project wouldn't have been possible without the help and support of :
Charlie Cooney, Nicholas . A Farkas, Paul Bégin, Dr. Alison Murray, John O'Neill, Velson Horie, Greg Hill, Nicolas Brophy.