# *Effects of Concentration and Artificial Ageing on the Strength and Reversibility of Dynmaic® 208 Wallcover Adhesive*

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## Abstract

Deteriorated marouflaged murals have been treated by conservators in a variety of ways but little scientific testing on the techniques, their reversibility, and ageing characteristics exists in the current literature. There is a need to find adhesives that will remain chemically stable and mechanically reversible when used for re-adhering conserved murals to their original substrates. It is not the intention of this research to find the perfect adhesive, but to provide a preliminary investigation into one commercial wallpaper adhesive, Dynamic® 208, currently being used in the field. The concentration of the adhesive, and the addition of interleaving, was varied with the objective of finding a technique that would achieve ease of reversibility and maintenance of bond strength. Samples were subjected to tensile peel strength testing, FT-IR ATR analysis and qualitative reversibility testing. Testing was done before and after thermal accelerated ageing to assess mechanical properties, chemical composition and reversibility.


**Ideal marouflage adhesive characteristics:**
- Viscous paste
- Easy to apply evenly
- Slow - medium setting time
- High tack and bond strength
- Easily released mechanically

*Figure 1. Dynamic® 208 Clear Wallcovering Adhesive*

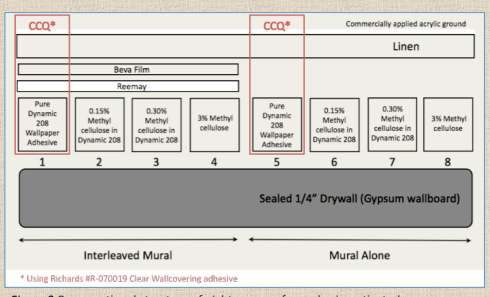



*Figure 2.*Cross sectional structure of eight groups of samples investigated

## Background Information

Marouflaged mural painting is the technique of adhering a canvas painting to a solid architectural substrate. Wallpaper adhesives exhibit many characteristics needed for the Marouflage technique (Fig. 1).

***Current conservation approaches:***

•Local consolidation *in situ*
•Full removal, addition of lining or interleaf, and reinstallation on original substrate
•Full removal and remounting on a new solid support

***Issues:***

Conservation treatment significantly alters the original aesthetic qualities of marouflaged murals. Authenticity should be preserved whenever possible by using the least invasive techniques.

***This study follows a project carried out by the Centre de conservation du Québec (CCQ) in 2008.***

•Need to devise a treatment plan for a group of canvas murals by Charles Huot (1855-1930)
•In consultation with AIC, a commercial wallpaper adhesive was selected (Fig. 1)
•Testing of two techniques, canvas with an interleaving layer (Fig. 2, group1) and without (Fig. 2, group5)
•Interleaved technique chosen for ease of mechanical reversibility after 24 hour setting period

## Experimental

| Thermal Ageing Set. 2 (130 samples) | Qualitative Analysis: FT-IR ATR (18 samples) | Qualitative Reversibility Testing (80 samples) | Mechanical Strength Testing: Tensile Peel Test (150 samples) |
|---|---|---|---|
| • Despatch LEA series Chamber 1-69<br>• 80°C and 65% RH for 19 days<br>• Parameters chosen based on studies related to ageing of cellulosic materials and adhesives | • Nicolet Avatar 320Fourier transform infrared (FT-IR) spectrometer with attenuated total reflectance (ATR) accessory<br>• Identification of unknown ingredients<br>• Assess composition of adhesive solutions before and after ageing | • Five conservation students mechanically separated the adhesive bond of samples, then rated them based on ease of separation<br>• Layered structure of samples seen in Fig. 2<br>• The average reversibility rating (%) results were tabulated and colour coded as follows:<br>Poor <25% \| Caution 26-49% \| Fair 50-75% \| Good >76% | • Instron Universal TTDL Vertical Tensile Tester (1000 lbs, cross head speed of 1"/min)<br>• Assess bond strength of samples before and after ageing<br>• Layered structure of samples and orientation during peel testing seen in Figs. 2 and 3 |

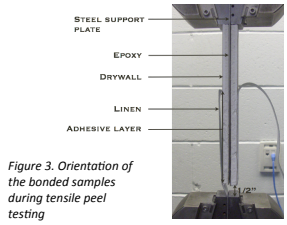



*Figure 3. Orientation of the bonded samples during tensile peel testing*

## Results

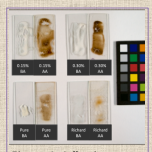


*Figure 4. Adhesive samples before ageing (BA) and after ageing (AA), showing discolouration (above)*

No notable difference seen in adhesive spectra after ageing, implying the composition remained unchanged. However, it was visually evident that sample solution containing the commercial wallpaper adhesives became discoloured (Fig. 4).

Analysis of FT-IR spectra for pure Dynamic® 208 provided basic conclusions about the main ingredients in the wallpaper adhesive (Fig. 5).

•Cellulose based adhesive; spectra resembles wheat starch
•Broad absorption at 1340 $cm^{-1}$ and sharp peaks at 835 and 1790 $cm^{-1}$ show sodium nitrate is present in the adhesive.

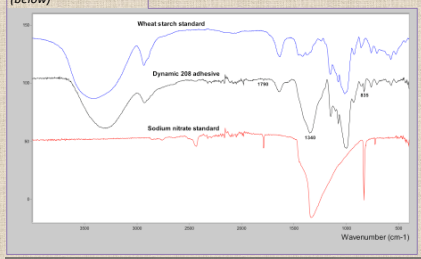


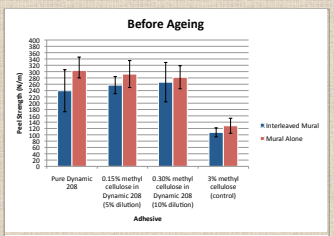

*Figure 5. IR spectra of Dynamic® 208 compared to stock spectra of wheat starch and sodium nitrate (below)*

Overall, Dynamic® 208 remained mechanically reversible to a fair degree, before and after ageing, with and without an interleaving layer. Though all samples without interleaving had slightly higher reversibility ratings, all participants reported that interleaving facilitated safe bond separation (Table. 1).

*Table 1. Overall Variation in Reversibility (%)*

| Sample | Average Reversibility Rating (%) |
|---|---|
| Pure Dynamic 208: Linen | FAIR |
| Pure Dynamic 208: Interleaved linen | FAIR |
| | |
| 5% dilution of Dynamic 208: Linen | FAIR |
| 5% dilution of Dynamic 208: Interleaved linen | FAIR |
| | |
| 10% dilution of Dynamic 208: Linen | GOOD |
| 10% dilution of Dynamic 208: Interleaved linen | FAIR |
| | |
| 3% methyl cellulose (control): Linen | FAIR |
| 3% methyl cellulose (control): Interleaved linen | GOOD |

Interleaved samples maintained stronger bonds after ageing than samples without interleaving. Methylcellulose maintaining the highest bond strengths was an unforeseen result that will require further investigation (Figs. 6 and 7). Dilution of Dynamic® 208 affected the bond strength of the adhesive, but not following the expected trend (Fig. 8). This further implied that the interleaving played a more prominent role in the bond strength then the concentration of the adhesive solution.



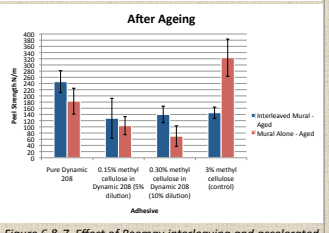




*Figure 6 & 7. Effect of Reemay interleaving and accelerated ageing on peel strength (N/m)*

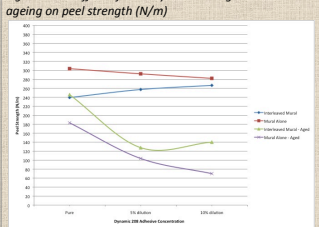


*Figure 8. Effect of concentration on peel strength (N/m)*

## Conclusions

Results indicate that the practice of interleaving is beneficial, providing higher bond strength and maintenance of safe mechanical reversibility after ageing. Unfortunately, using Dynamic® 208 as a long-term adhesive for conservation treatments is not advised because adhesive discolouration is a major concern and could potentially cause changes in the appearance of treated murals over time. Further investigation of the stability and ageing characteristics of Dynamic® 208 is warranted. Diluting Dynamic® 208 by 5% maintained adequate bond strength but 10% appeared to weaken the bond too much for reattachment treatment of canvas murals. A study comparing multiple commercial products and homemade recipes as well as more research on various solution concentrations is recommended. Further research could assist in finding appropriate adhesives for use with marouflaged murals and the development of testing standards.

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