Investigating Accepted and Innovative Materials for Glass Fills

Katharine Shulman,* Lauren Fair, and Catherine Matsen

Winterthur/University of Delaware Program in Art Conservation

ICOM-CC ICOM international council of museums – committee for conservation

Introduction

Fill material options for glass are limited, and each has benefits and drawbacks. Typical choices are epoxies, polyester resins, and Paraloid B-72, but there is interest to find new materials with better working properties, chemical stability, and reversibility.

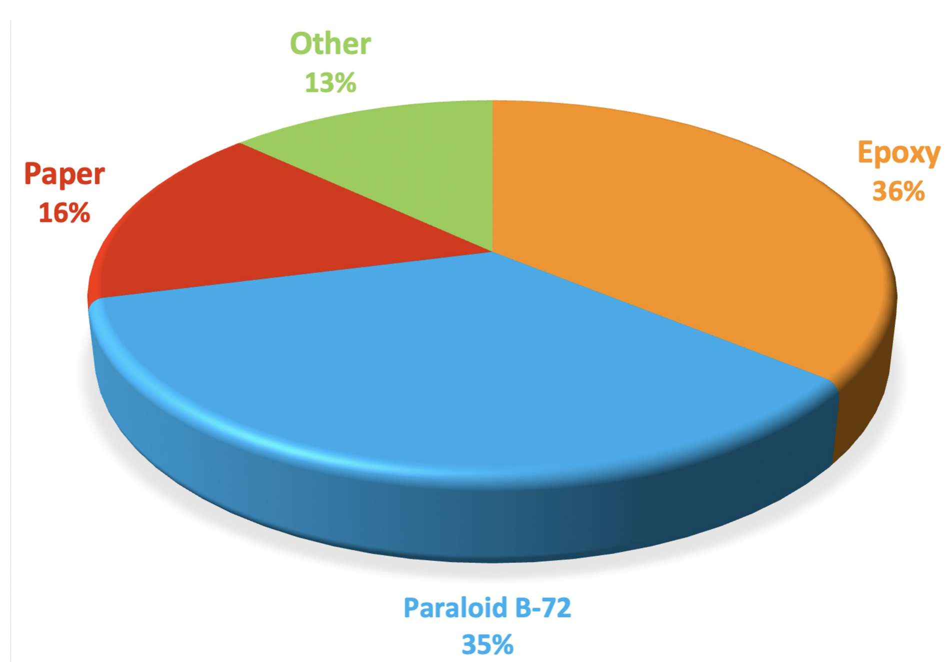
This study compares data for using well-established materials for glass and researches new possibilities by reading published studies, surveying colleagues, and testing each method.

Data Collection

After reviewing published sources that discuss loss compensation for glass in conservation, we turned to our colleagues to get anecdotal evidence of the most common glass fill materials being used in conservation labs today.

A survey was widely distributed across the United States and abroad, and participants were asked about preferred and alternative methods and materials for glass fills in their work. Ultimately, 25 conservators responded to the query.

Survey Results



As expected, epoxy and Paraloid B-72 are favored fill materials for glass. Mulberry paper is gaining more traction; however, it is typically only used on archaeological glass, not decorative glass where desired clarity is an issue.

All materials and methods mentioned in survey responses:

Epoxies	B-72	Paper	Other
-Hxtal NYL-1 -Epotek 301 -Epotek 301-2 -Araldite 2020	-Solvent-cast -Thermocast -B-72/B48-N mix	-Adhered with Paraloid B-72 -Impregnated with Paraloid B-72 -Adhered with methylcellulose	-Nanocellulose -Agar -Mylar -Glass -Glass frit in clear silicone -Urethane resin

Experimentation

The following fill materials and techniques were tested on study collection glass objects varying in color, thickness, and clarity. The working properties and aesthetic viability of new and innovative materials were compared to traditional ones.

TRADITIONAL

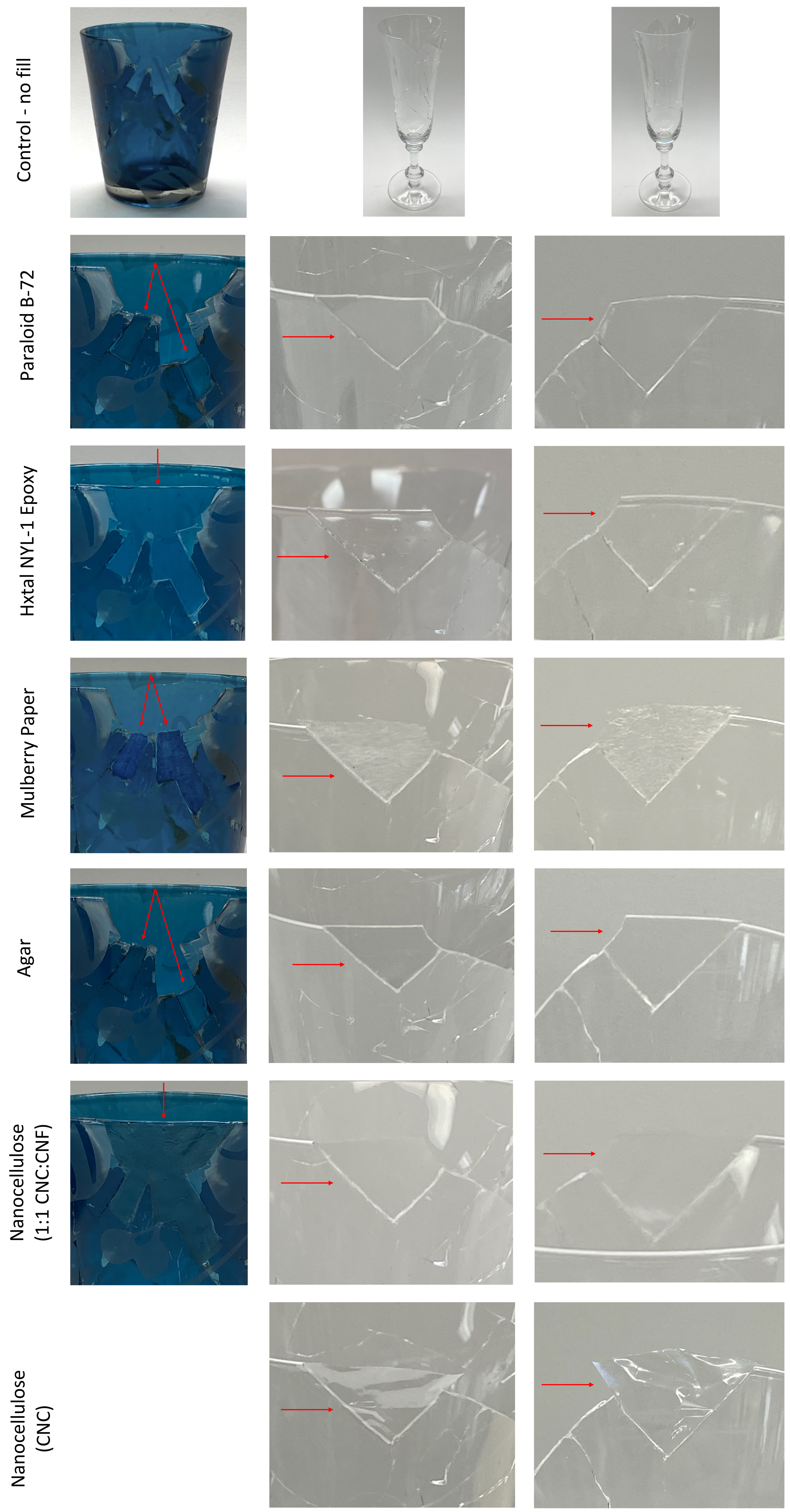
- **PARALOID B-72**
  - pre-cast in silicone molds and cut to shape
- **HXTAL NYL-1 epoxy**
  - cast in situ with silicone molds
  - cast in situ with PVC sheet and silicone backings
  - casting into a mold off the object
- **Mulberry paper**
  - cut to shape, acrylic-coated and toned

INNOVATIVE

- **Benchmark Agarose LE**
  - cast in plasticine molds on sheets of glass and cut to shape
- **Cellulose Nanocrystals (CNC) nanocellulose**
  - cast in polyethylene petri dishes lined with silicone-release Mylar and cut to shape
- **1:1 Cellulose Nanocrystals/Nanofibrils (CNF)**
  - cast in polyethylene petri dishes lined with silicone-release Mylar and cut to shape

Working Properties: PROS & CONS

PARALOID B-72	
+ Stable + Reversible + Form with solvent or heat + Strong + Clear + Good refractive index + Good bonding	- Bubbles! - Moderate Tg - Affected by solvents - Time-intensive curing - Shrinks on drying - Bad for large/complex losses
HXTAL NYL-1	
+ Sets by chemical reaction + Strong + Clear + Good refractive index + Good bonding	- Yellows over time - Can be too strong - Not easily reversible
Mulberry paper	
+ Stable + Reversible + Easy to make and tone	- Lacks structural support - Does not conform to curves - Not optically clear
Agarose	
+ Reversible + No bubbles + Clear + Good bonding	- Yellows over time - Affected by water and high RH - Difficult to build up thickness
Nanocellulose (CNC and 1:1 CNC/CNF)	
+ Stable + Reversible + Clear + Easy to make + 1:1 mix is more structural	- Thin - Iridescent or cloudy - CNC prone to tearing and wrinkling

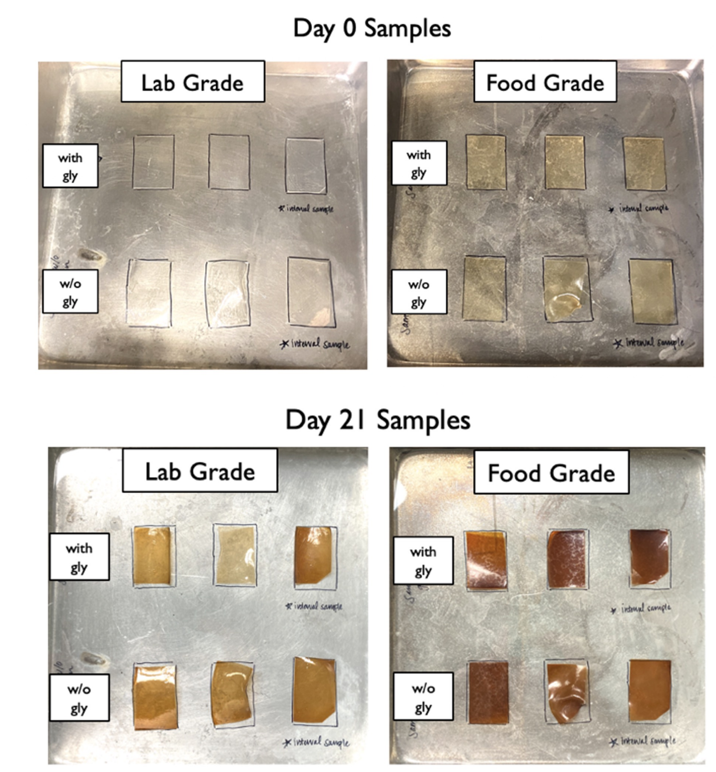


Analysis of Agar

To understand degradation mechanisms and detect physical and chemical change, cast samples of lab- and food-grade agar (with and without the addition of glycerin as a plasticizer) were artificially aged at 80°C at 65% RH for 21 days.

Aged samples were catalogued using visual observation, thickness measurements, colorimetry, FTIR, and py-GCMS. All samples dramatically changed color and thickness after aging, obvious with and without instrumentation. However, chemical changes were not detected with FTIR or GCMS.

These results demonstrate potential problems with agar as both a conservation material choice and as a component of bioplastic-based artwork. **It should be noted, however, epoxies and Paraloid B-72 would also show undesirable dramatic change if subjected to this aging regime.**



Conclusions

Conservation studies for glass fills to-date focus heavily on epoxies and Paraloid B-72. While each has obvious practical benefits, their respective drawbacks necessitate research into alternative materials.

Despite its challenges, agarose stands out as a potentially viable option and deserves further research and experimentation.

We hope this project serves as a helpful summary of the current state of conservation fills for glass and as a jumping-off point for those seeking alternative materials with potentially better working properties.

Acknowledgements

We would like to acknowledge artist Yi Hsuan Sung whose beautiful agar artworks inspired this project. Special thanks to Drs. W. Chris Petersen and Jocelyn Alcántara García for their assistance with GC-MS and artificial aging.