Article: Analysis of restoration materials: The Campbell Collection at Winterthur Museum
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ANALYSIS OF RESTORATION MATERIALS: THE CAMPBELL COLLECTION AT WINTERTHUR MUSEUM

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Abstract

In 1996, the H. F. DuPont Winterthur Museum acquired a collection of ceramic and metal soup tureens and related objects from the Campbell Museum in Camden, New Jersey. The majority of the collection dates to the 18th - 19th centuries, and is of American and European manufacture. Examination of the objects indicated that many of the ceramic tureens had been restored in the past. However, information about previous restorations in the Campbell Museum's files was incomplete or nonexistent.

For the exhibit *The Campbell Collection of Soup Tureens at Winterthur*, 137 pieces from the collection were selected, and the objects were examined and conserved in Winterthur's Objects Conservation Laboratory. In treating the previously restored ceramic objects, one of the first decisions to be made was whether previous restorations should be reversed. With the curator, conservators established a list of criteria to guide the decision-making process. If a restoration was reversed, the methods used were recorded; the appearance of the materials used in normal and long-wave ultraviolet light was noted; and samples of adhesives, fill material and inpainting/coating materials were collected and analyzed using a variety of instrumental techniques. The goal of the analyses was to provide a better understanding of the types and variety of materials used in the restoration of ceramic objects in the Campbell Collection. The results of the analyses were also compared with lists of materials suggested for use in ceramic conservation and/or restoration, collected during a literature search. Because the restoration records for the Campbell Collection were limited, comparison of the analytical data with the literature gave an opportunity to compare the actual types of material used to restore the tureens with the material being used commonly by restorers and conservators reported in the literature.

1. Introduction

In 1966, John T. Dorrance, Jr., then chairman of the board of the Campbell Soup Company, suggested that the company begin acquiring soup tureens. From that beginning the collection grew to include over 300 metal and ceramic objects, all in some way related to the service or consumption of soup. The strength of the collection lies in 18th and 19th century objects made in England, continental Europe and North America. Silver tureens made by English firms of Garrard and Company, and Rundell, Bridge and Rundell, are included in the collection, as well as a silver ladle made by Paul Revere of Boston. Ceramic tureens are representative of the work of many famous ceramic manufactories in continental Europe and England, including Meissen, Sèvres, Chelsea, Staffordshire and Worcester. There are also a number of tureens made by contemporary artists in the collection. Many of the tureens were on permanent display at the Campbell Museum in Camden, New Jersey, at the Campbell Soup Company corporate headquarters. A smaller component of the collection was shown extensively throughout the United States in a traveling exhibition.

In March 1996 the Campbell Museum's collections were donated to the H. F. DuPont Winterthur Museum for exhibit in a new gallery named in honor of the Dorrance family. The Objects Conservation Laboratory at Winterthur was called upon to examine the 137 objects chosen for the new installation, and to establish a treatment plan to prepare the objects for exhibit. It was immediately apparent that all of the objects would need some level of conservation. As with many small museums, the Campbell Museum did not have a staff conservator and, for the most part, objects in the collection had not been treated after acquisition. The 40 metal objects chosen for exhibit would subsequently prove to be the most straightforward in terms of treatment needs. All but one of these objects was made of silver; treatment for most consisted of tarnish removal with mild abrasives followed by the application of a lacquer coating.

The 97 ceramic objects presented a far greater challenge, however. Preliminary condition surveys indicated that almost half of these objects were in good structural and aesthetic condition, and would require only surface cleaning to remove dirt and grime. The balance of the ceramic group had undergone some level of restoration in the past. Examination of the restorations revealed that aesthetic considerations had been given a high priority in earlier restoration work. In addition to reassembly of fragments and replacement of missing elements, manufacturing defects such as firing cracks had been filled and inpainted to minimize their visual presence.

It appeared that the conservation of the Campbell collection objects would provide an opportunity to study the materials used in previous restorations. A program was established whereby samples of restoration materials removed in the course of a treatment were saved for analysis by Winterthur's Analytical Laboratory. The goals of the analyses were to learn more about the range of restoration materials used in the past, to use the analytical information to assist in the choice of appropriate solvents or methods to reverse previous treatments, and hopefully to help in establishing a time framework for the previous restorations.

Each ceramic object was evaluated individually and treatment decisions were made based on the needs of the object. For the previously restored ceramic objects, the decision to remove old restoration materials was made jointly with the curator. The following criteria were used:

1) aesthetic appearance of the restoration;
2) physical stability of the object or the restoration
3) accuracy of the restoration; and
4) the constraints of the project timetable.

The aesthetic appearance of the restoration was usually the easiest factor to judge. Over time, the in- and overpaint used on many of the restored objects had darkened or yellowed, and now only served to draw attention to the restoration rather than to disguise it. There was unanimous agreement that restoration material in this condition should be removed. With regard to physical stability of restorations, the most common problem was embrittled restoration paint which was flaking from the surface of the object. In contrast, adhesive joins and fills were generally stable and therefore of less concern than the paint.

Many of the previous restorations had greatly changed the appearance of the object. The most common examples involved extensive overpainting, done to disguise major repairs. In many cases, paint had been applied to all surfaces of a tureen, cover or stand in an effort to cover a break line or a relatively small loss. In the process, many decorative elements had been reinterpreted. For example, flowers found in the overpaint of a cover did not exist on the original object. Once again, the decision to remove this kind of restoration was unanimous.

Less frequently, inaccurate restoration had resulted in reinterpretation of the physical shape of the object. For example, the restored handle from a two-handled soup bowl did not match the extant handle in size or shape. In another case, when both handles of a tureen had been readhered to the object, the length of the handles had been shortened. The restoration with the truncated handles created a profile which differed significantly from that of other tureens made in the same factory. In order to present the object accurately, it was decided that the handles should be removed and the length increased to accurately reflect the appropriate size.

Finally, the tight scheduling for exhibit preparation and installation, which required the treatment of 137 objects in 13 months, mandated that certain previously restored objects could not be treated. For those objects with physically stable restorations, deemed by the curator to be historically accurate and aesthetically acceptable, the decision was made to leave the restoration intact.

After examining all of the restored ceramic tureens with the above factors in mind, 37 restored tureens in need of re-conservation were identified. In all, 115 samples for analysis were collected from these objects in the following categories: adhesives, fill material, and inpaint/coating material.

2. Examination of Restorations

2.1 Ultraviolet Light Examination

All ceramic objects in the collection were examined using long-wave ultraviolet light (365 nm); a short-wave ultraviolet light source was not available for the project. In general, the overpaint of the restorations fluoresced bright white or a dull yellow in comparison to the original ceramic surface. Occasionally, glue joins or overpaint fluoresced orange, suggesting the presence of shellac.

2.2 Restoration Methods Used

In the initial examination of the objects and as treatment proceeded, a number of observations about the restoration methods used for this collection were made.

The surfaces of many of the objects were severely abraded, most often at break edges. This may indicate that inconsistencies at break edges caused by the misalignment of fragments during reassembly were evened out by abrasion. In many cases, abrasion had removed decorative elements which were then repainted. On all abraded surfaces, the glaze was duller, and a coating or paint had been applied, apparently to give the surface a more lustrous appearance. In some cases, firing cracks had been made deeper or wider, possibly to provide more surface area and better adhesion of the fill material to the ceramic surface.

In the course of the project it became evident that many objects had undergone at least two or even three restoration campaigns. For example, breaks had been repaired with rivets or staples, as evidenced by drill holes on either side of the break or channels cut in the surface across the break to receive the rivet/staple. However, the rivet/staple had subsequently been removed and the fragments were now held together with an adhesive, and drill holes and channels had been filled and inpainted. None of the Campbell collection objects chosen for the exhibit currently contain rivets/stables; any fragments once held together mechanically are now held together with adhesive.

Two restoration techniques were each found only once within the collection. The first was the use of a ceramic element (in this situation a handle) to replace a missing element on an object. In the second, a flat piece of metal had been inserted into a channel cut at the top of a crack for stabilization.

By far the most common restoration technique observed in the Campbell collection objects was the use of extensive overpainting, well beyond the area of repair, done to blend restoration work with the original and ensure that it was invisible.

3. Analysis of Restoration Materials

The analysis of the restoration materials was achieved primarily through the use of energy dispersive x-ray fluorescence spectroscopy (XRF) and Fourier transform infrared microanalysis (FTIR). XRF is a non-destructive technique for elemental analysis. Elements above atomic number 18, argon, on up through the rest of the periodic table can be detected. For most of the Campbell samples, which were quite small, the sample was lightly affixed to a strip of Scotch tape and then suspended in front of the x-ray beam. A molybdenum secondary target at 30 kV and 0.5 ma was used with a 200 second irradiation time. Because of limited sample size, response for most elements was weak but sufficient for identification. No attempt was made to physically separate fill from accompanying overpaint materials for XRF analysis because of limited sample size.

For micro-FTIR analysis, the sample was first examined under a binocular microscope. Where necessary or appropriate, discrete layers or components were physically separated. A tiny portion of each sample component was then transferred under a microscope to the surface of a diamond compression cell where it was rolled flat to an appropriate thickness for analysis. In some cases, samples were additionally extracted with chloroform or acetone for further FTIR analysis. FTIR spectral interpretations were confirmed by computer spectral search and by comparison with hard copy reference spectra.

The complexity of some of the samples is illustrated in Figure 1, an FTIR spectrum which shows three distinct layers in the an overpaint sample taken from an ecuelle. The top layer was found to be an acrylic material, while the middle and lower layers were nitrocellulose.

An advantage to both XRF and micro-FTIR analysis is that the sample is not consumed, and can be reused for other analytical purposes. However, as with all analytical techniques, certain limitations exist. For instance, XRF analysis is limited by the fact that it does not detect lower atomic number elements such as silicon, magnesium and aluminum; therefore such fill materials as talc, kaolin and other silicates are not detected and calcium containing compounds such as calcite and gypsum cannot be completely characterized. However, as most of these minerals absorb in the mid-infrared range, they are detected by FTIR as is seen in Figure 2 which shows the presence of plaster and kaolin together with cellulose nitrate.

FTIR analysis was complicated by the fact that all samples were mixtures of two or more components with frequently overlapping spectral bands. FTIR is not usually useful for mixture components in concentrations of less than 5-10%; nevertheless, through careful comparison with reference spectra and selective extractions with appropriate solvents, the major components of all samples were readily identified. Figure 3 shows the spectrum of a fill material before and after chloroform and acetone extraction. With extraction the very strong carbonate bands from the lead white pigment are diminished sufficiently to permit identification of the organic component as a natural plant resin.

To date, 29 of the 115 samples have been analyzed. Table 1 summarizes the results of these analyses.

The number of inorganic materials, used either as fill materials or as pigments or both, were fairly limited. Titanium, presumably as the pigment titanium dioxide, was detected in the majority of paint and fill materials. Lead white was identified as the sole pigment in one overpaint, and together with titanium white in two others. Zinc white was the sole inorganic component in an adhesive and was found together with titanium and calcium in two others. Calcium compounds, either calcium carbonate or plaster of Paris (calcium sulfate hemihydrate), were found in several instances. Silicate compounds such as talc (magnesium silicate) and kaolin were found in numerous samples as well. A metallic fill material found in old rivet/staple holes of a Derby tureen handle (96.4.221 a-c) was identified as a pewter-like tin-lead alloy, perhaps derived from a solder. Metal particles, possibly iron, were detected together with the more common calcite and talc in a gray-colored epoxy-butylated urea-formaldehyde fill used to repair a Meissen spoon (96.4.257). Copper and zinc were found in an epoxy-based metallic paint, indicating the use of a bronze powder pigment used to restore lost gilding on a Chinese export porcelain (96.4.196 a-c).

With only two exceptions, media for overpaint and/or fill materials were synthetic materials. Natural resins, probably of plant origin, were found in a fill sample from a Chinese export porcelain object (96.4.196a-c), and in an overpaint sample of a tureen made at Vincennes (96.4.245 a,b). Since these resins were found only in conjunction with historic pigments such as lead white and calcium carbonate, it is possible that they represent the oldest repairs. Cellulose nitrate, plasticized with an aromatic ester component, or as a modifier in an alkyd resin, appeared in eight samples. The inorganic components associated with cellulose nitrates were usually plaster of Paris, calcite, talc or clay. A second large group of resins, found on 11 objects, were typical epichlorohydrin-bisphenol A type epoxies, either alone or together with one of two different urea formaldehyde resins. Figure 4 shows an epoxy together with a urea-formaldehyde; in the same object epoxy is also used with a butylated urea formaldehyde. Acrylic resins were found in two samples, while a urethane-modified alkyd was found in one sample. The inorganic material most commonly found in association with the epoxy resins was talc, either alone or together with an additional silicate component.

4. Review of Ceramic Restoration/Conservation Literature

At the outset of this project one of the goals was to use analytical data to compare the kinds of materials used to restore the Campbell Collection objects with the kinds of materials in use during the early to middle 20th century, the period in which it seemed likely that the restoration were carried out. The collection files maintained at the Campbell Museum contained little information relating to the condition of most objects at purchase, or during their tenure at the Museum. When objects were purchased their condition, particularly the presence of restoration, was usually not documented. For example, no comments were made regarding the condition of a Chelsea tureen and cover (96.4.222 a,b) when acquired by the Campbell Museum. But when examined for the Winterthur exhibit, the tureen was found to have been broken into four large fragments, and had undergone two campaigns of restoration. In the first campaign the fragments had been reassembled using rivets. The rivets were removed in the second campaign and replaced with adhesive, and the interior and exterior surfaces completely overpainted.

If a flaw was noted in pre-acquisition documentation, correspondence indicated that the dealers negotiating the sale would have the problem taken care of before the object was delivered to the Museum. This was the case for the bowl of a tureen and cover made at Vincennes (96.4.245 a,b). The dealer from whom it was purchased assured the Campbell Museum that the flaw would be restored before the object was delivered to the Museum. It was, but there is no notation indicating who carried out the restoration or what materials were used.

Of those objects restored after acquisition by the Campbell Museum, a full conservation treatment report existed for only one object. Other restorations were inferred by invoices for the work done, or by memoranda detailing shipping information for the transfer of the object to the restorer's studio and then back to the Museum. The files also indicated that most of the restoration work had been done primarily by professional restorers working for the dealers or owners selling the pieces to the Campbell Museum.

The literature search for material on ceramic conservation/restoration techniques and materials was focussed on sources which discussed ceramic restoration/conservation in a general way, rather than sources which detailed restoration/conservation techniques and materials for a single object. It was thought that this approach to the literature would have a broader application at this point in the project. It is anticipated that as the analysis of the restoration materials found in the Campbell Collection continues the literature search will broaden to include those sources.

Even in this limited literature search a number of sources were found and reviewed. Many of the sources seem to fall into the category of training manuals for the interested amateur (for example Cross 1973; Everett 1976; Malone 1972; Pond 1970). Others, (for example Andre 1976, Larney 1973; White 1981) were written as a guide for the general public by restorer/conservators with long experience in the field, in private and museum settings. Three of the sources (Buys and Oakley 1993; Larney 1971; Tennent 1982) were written specifically for the professional restorer/conservator.

The materials recommended in these sources is summarized in Tables 2, 3 and 4. There is a significant correlation to be found between the materials suggested for use in ceramic restoration/conservation and the materials used in the Campbell Collection. This would seem to indicate that the restoration work performed on the tureens fell within the norm of treatment as indicated in the literature.

5. Continuing Research

5.1 Analysis of Commercial Restoration Products

The literature survey indicated that many proprietary materials were used or recommended for use in the restoration of ceramics. For example, specific brands of epoxy (e.g. HXTYL NYL-1 and

Devcon 2-Ton) are recommended for use, or a specific brand of loss compensation (Milliput or Sculpy) is recommended. An area of continuing research will include analysis of samples of proprietary materials using XRF and FTIR, to build a set of reference materials against which restoration materials from other ceramic objects can be compared.

An example of this type of work is found in Table 5 which summarizes the analysis of materials in the Master Mending Kit, a group of proprietary materials which were produced to accompany the book *How to Mend Your Treasures* by L. A. Malone. Presumably this kit would have been available since the publication of the book in 1972, and it is available today from Conservator's Emporium in Reno, Nevada.

5.2 Monitoring Restoration Materails in the Dorrance Gallery

Examination of previously the restored tureens had given evidence of the instability of the materials used. In many instances adhesives, inpainting and coating materials had physically failed or had darkened or yellowed, becoming aesthetically inappropriate. With this in mind, the color stability of restoration materials not removed prior to installation in the Dorrance Gallery was of concern to conservation and curatorial staff. To add to the problem, the Gallery has floor to ceiling glass windows on two sides, and although the window glass and the exhibit case glass have U.V. filters, there is an enormous amount of light in the Gallery. Though the design gives the exhibit space a light an airy feeling, the exhibit environment will probably accelerate the further degradation of the old restoration materials as well as the materials used in new conservation campaign.

To monitor this, a program to study color changes in a specific sample of both old and new restoration materials has been established. Using a Minolta Chroma Meter CR-100, readings of specific locations of a group of objects (with both old and new restoration materials) will be taken at six month intervals and any changes will be noted. This information will be correlated with the analytical data.

6. Conclusions

Examination of restored ceramic objects and restoration materials from the Campbell Collection prepared for the exhibit *The Campbell Collection of SoupTureens at Winterthur* has provided a window to restoration materials used in the mid-20th century. However, with only a quarter of the restoration material samples analyzed, it would be inappropriate to draw final conclusions about the restoration materials used for for the Collection. Preliminary results confirm that a variety of synthetic materials, with and without fillers was used. These tata correlate with conserfation literature. It is expected that further research will broaden our understanding of these materials and methods.

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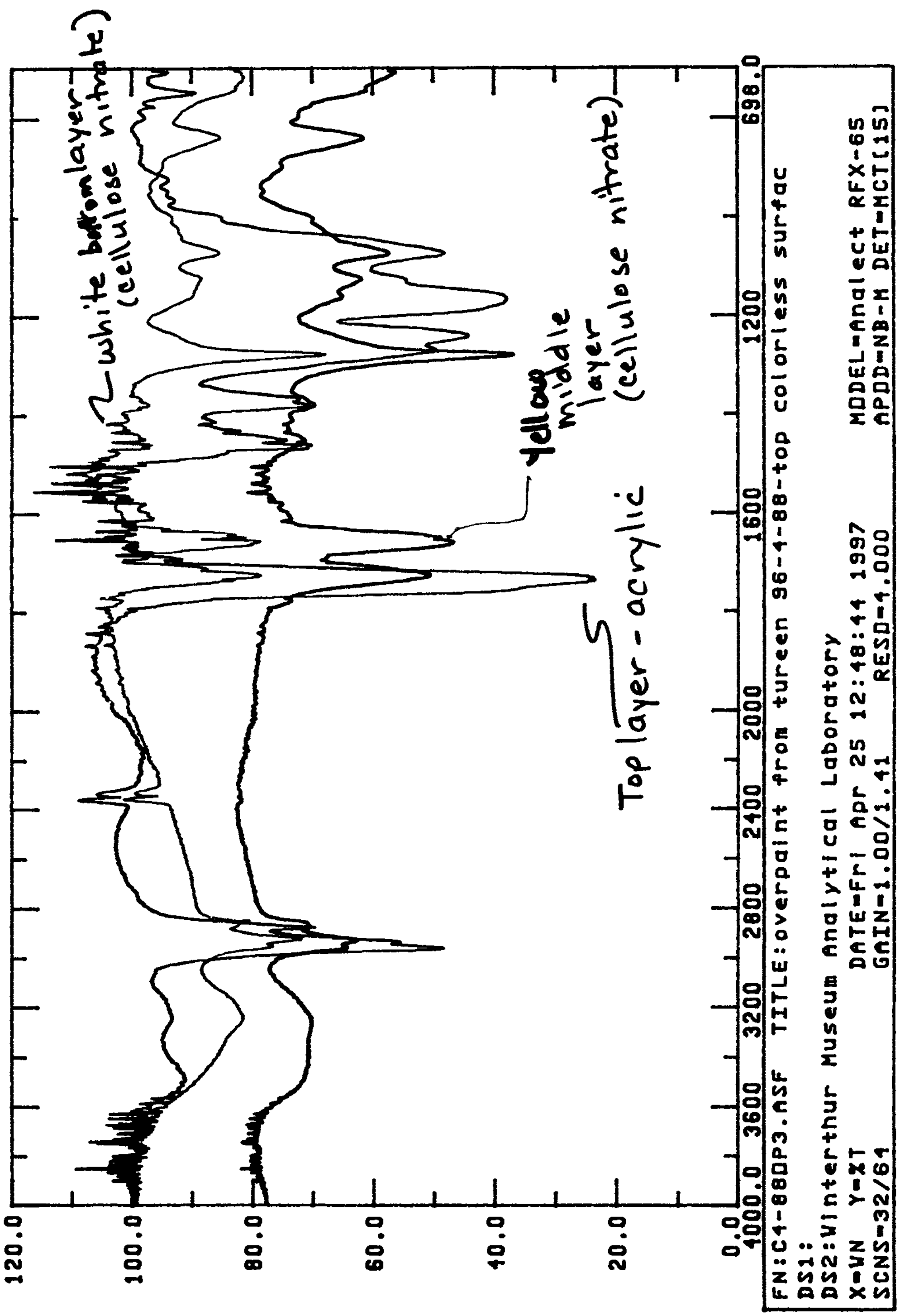
Figure 1

FTIR Spectrum of Paint Sample from Ecuelle (96.4.88) Showing Three Discrete Layers



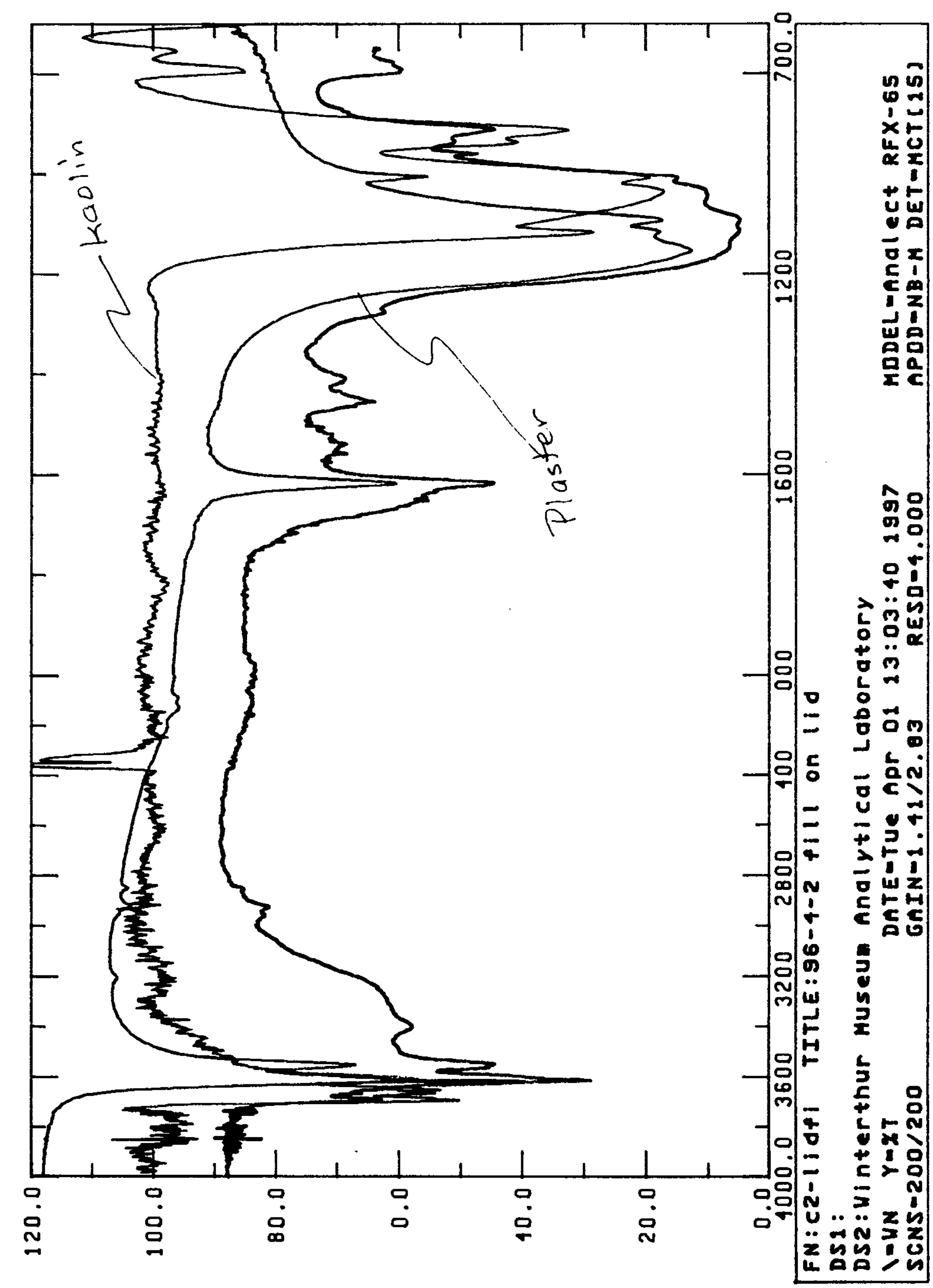


Figure 2

FTIR Spectrum of Fill Sample from Tureen (96.4.2)
Showing the Presence of Plaster, Kaolin and Nitrocellulose

Figure 3

FTIR Spectrum of Fill Material from Tureen (96.4.245)
Before and After Chloroform and Acetone Extraction

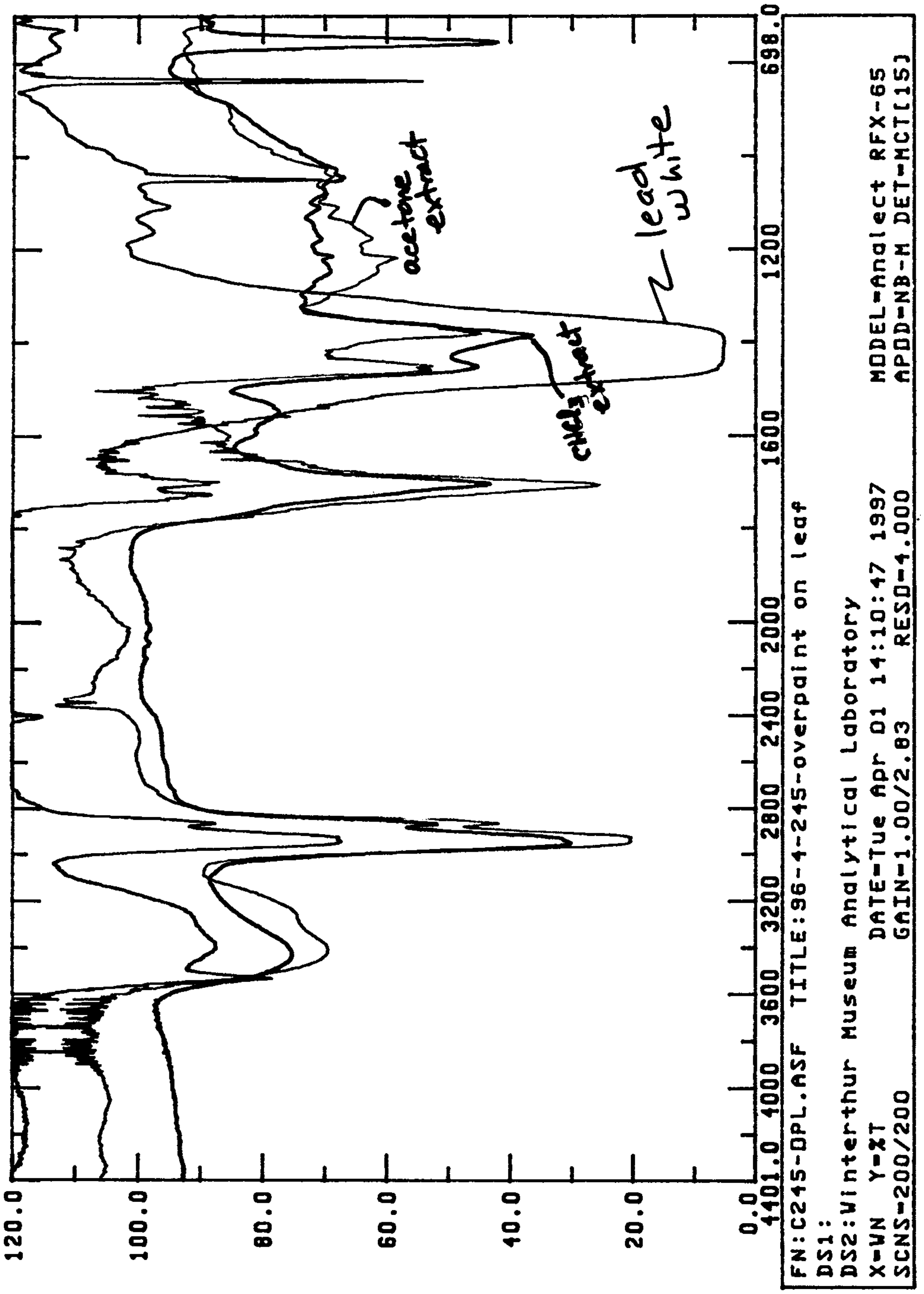
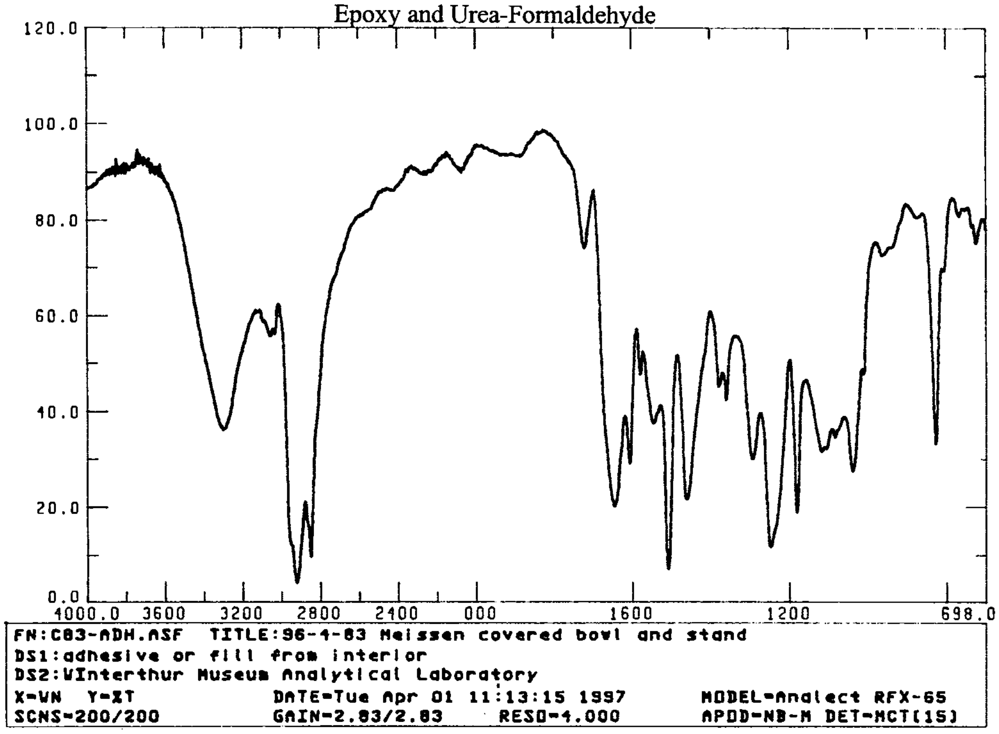


Figure 4

FTIR Spectra of Fill and Adhesive Material from Bowl (96.4.83)

Epoxy and Urea-Formaldehyde



Epoxy and Butylated Urea-Formaldehyde

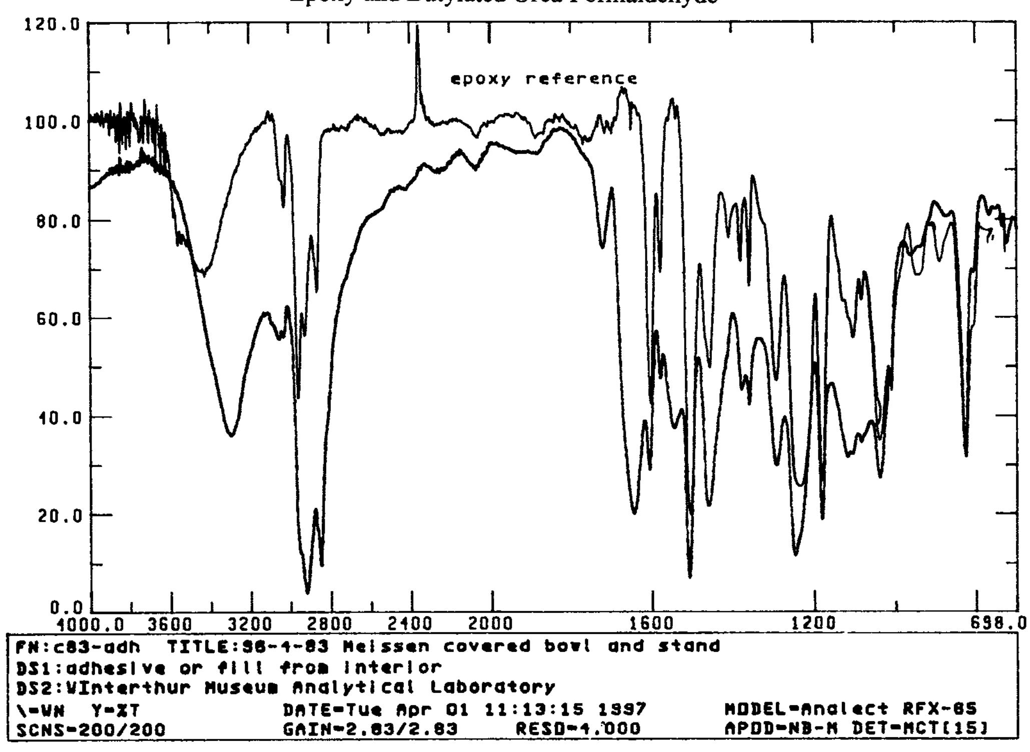


Table 1

Analysis of Restoration Materials from Campbell Collection: Results of Instrumental Analysis

ACCESSION NO.	OBJECT	SAMPLE TYPE	SAMPLE AREA	XRF: ELEMENTS	FTIR: ORGANIC	FTIR: INORGANIC
96.4.2 a,b	Tureen and Cover	Fill	Cover	Ca, Ti, Sr, Fe	Cellulose Nitrate	$2CaSO_4.H_2O$, Clay
96.4.2 a,b	Tureen and Cover	Overpaint	Exterior Lid, Pink	Ti, Pb	Cellulose Nitrate	Lead White
96.4.2 a,b	Tureen and Cover	Overpaint	Exterior Lid, White	Ti, Pb	Cellulose Nitrate	
96.4.2 a,b	Tureen and Cover	Overpaint	Interior Lid	Ti	Nitrocellulose Modified o-phthalic Alkyd	
96.4.3 a,b	Tureen and Cover	Overpaint	Exterior Tureen	Ti, Ca	Cellulose Nitrate/Ester Plasticizer	
96.4.83 a-c	Bowl, Cover and Stand	Adhesive	Handle of Bowl	Zn	Epoxy+butylated Urea-Formaldehyde	
96.4.88 a-c	Ecuelle, Cover and Stand	Overpaint	Bottom Layer, Cover	Ti	Cellulose Nitrate	
96.4.88 a-c	Ecuelle, Cover and Stand	Overpaint	Middle Layer, Cover	Ti	Cellulose Nitrate	
96.4.88 a-c	Ecuelle, Cover and Stand	Overpaint/Coating	Top Layer, Cover	Colorless	Butyl/Isobutyl Methacrylate	
96.4.88 a-c	Ecuelle, Cover and Stand	Fill	Cover	Ti	Cellulose Nitrate/Ester Plasticizer	$2CaSO_4.H_2O$
96.4.98 a-c	Tureen, Cover and Stand	Overpaint	Stand, p. Left Side	Ti	Acrylic (probable)	
96.4.98 a-c	Tureen, Cover and Stand	Overpaint	Stand, p. Right Side	Ti	Cellulose Nitrate/Ester Plasticzer	
96.4.107.1 a-c	Tureen, Cover and Stand	Overpaint/Coating	Cover	-	Urea/Formaldehyde+ Epoxy + Ester	
96.4.107.1 a-c	Tureen, Cover and Stand	Overpaint	Cover	Ti, Zn	Urea/Formaldehyde + Epoxy + Ester	

Table 1 (cont.) -- Analysis of Restoration Materials from Campbell Collection: Results of Instrumental Analysis

ACCESSION NO.	OBJECT	SAMPLE TYPE	SAMPLE AREA	XRF: ELEMENTS	FTIR: ORGANIC	FTIR: INORGANIC
96.4.160 a,b	Tureen and Cover	Coating	Cover	-	Bisphenol A - Epichlorohydrin Epoxy	
96.4.196 a-c	Tureen, Cover and Stand	Fill	Finial, Cover	Ca	Prob. Natural (Plant) Resin	$CaCO_3$
96.4.196 a-c	Tureen, Cover and Stand	Fill	Stand	Ca	Cellulose Nitrate/Ester Plastizer	Talc, $CaCO_3$
96.4.196 a-c	Tureen, Cover and Stand	Overpaint	Gold Colored Paint	Cu, Zn	Bisphenol A-epichlorohydrin Epoxy	
96.4.197 a-c	Bowl, Cover and Stand	Fill	Cover, Fill A	-	Bisphenol A-epichlorohyrin Epoxy	Talc
96.4.197 a-c	Bowl, Cover and Stand	Fill	Cover, Fill B	Ca(tr)	Epoxy + butylated Urea-Formaldehyde	Talc + Clays
96.4.197 a-c	Bowl, Cover and Stand	Overpaint	Cover, Overpaint A	Ti	Butylated Urea-Formaldehyde	
96.4.197 a-c	Bowl, Cover and Stand	Overpaint	Cover, Overpaint B	Ti	Epoxy + Butylated Urea-Formaldehyde	Talc + Clays
96.4.221 a-c	Tureen, Cover and Stand	Fill	Tureen Handle, Dowl Hole	Sn, Pb, Sb, Cu	XRF: Pewter or tin/lead solder	
96.4.221 a-c	Tureen, Cover and Stand	Overpaint		Cu, Fe, Ti, Ca	Buylated Urea-Formaldehyde	Talc
96.4.228 a,b	Tureen and Cover	Overpaint/Fill	Cover	Zn, Ti, Ca	Bisphenol A-Epichlorohydrin Epoxy	
96.4.245 a,b	Tureen and Cover	Overpaint	Cover, Leaf	Pb	Natural Plant Resin	Lead White
96.4.245 a,b	Tureen and Cover	Overpaint	Tureen, Exterior Surface	Ti, Pb	Urethane Modified o-Phthalic Alkyd	
96.4.257	Spoon	Fill	Grey Fill Material	Ca, Ti, Fe	Butylated Urea-Formaldehyde	$CaCO_3$, Metal Filings, Talc(?), CaSO
96.4.257	Spoon	Fill	Yellow Fill Material	Ca, Mn, Fe	Butylated Urea-Formaldehyde	Talc, Silicates

Table 2

Literature Review: Adhesives Suggested for Use in Ceramic Restoration/Conservation

Adhesive*	**Cited By:**
fish bladder glue	Andre, Yates
shellac	Andre, Parsons and Curl
cellulose nitrate	Buys and Oakley, Savage, Yates
gum mastic	Leland
gum mastic	Parsons and Curl
rosin/beeswax	Yates
whiting/silicate of potash	Leland
egg white/quicklime	Leland
casein	Leland
silicate of soda	Leland, Savage
cellulose acetate	Parsons and Curl
acrylic resin	Buys and Oakley
epoxy resin	Andre, Buys and Oakley, Cross, Everett, Evetts, Larney (1971), Larney (1973), Malone, Parsons and Curl, Pond, White
polyester resin	Andre, Buys and Oakley, Evetts, Larney (1971), Larney (1973)
polyvinyl acetate emulsion	Andre, Buys and Oakley, Everett, Evetts, Larney (1971), Larney (1973), Parsons and Curl
polyvinyl acetate resin	Buys and Oakley
cyanoacrylate	Andre, Evetts, Larney (1971), Larney (1973)
Acryloid B-72 (acrylic resin)	Buys and Oakley
UHU (cellulose nitrate)	Cross, Pond
HMG (cellulose nitrate)	Buys and Oakley
Duco Cement (cellulose nitrate)	Buys and Oakley, Everett
Vinamul 6815 (polyvinyl acetate emulsion)	Evetts
CM Bond M-3 (polyvinyl acetate emulsion)	Evetts
Evostick Resin 'W' (polyvinyl acetate emulsion)	Larney (1971), Parsons and Curl

Table 2 -- Literature Review: Adhesives Suggested for Use in Ceramics Restoration/Conservation

Adhesive*	**Cited By:**
Mowilith (polyvinyl acetate emulsion)	Larney (1973)
General and Sebralit (polyester resin)	Buys and Oakley
Akemi (polyester resin)	Buys and Oakley
Sintolit Transparent (polyester resin)	Evetts, Larney (1971), Larney (1973)
Alpha Aron (cyanoacrylate)	Evetts
Eastman 910 (cyanoacrylate)	Larney (1971), Larney (1973)
Cyanolit (cyanoacrylate)	Larney (1973)
Araldite (epoxy resin)	Cross, Everett, Evetts, Larney (1971), Larney (1973), Pond, White
HXTAL NYL-1 (epoxy resin)	Buys and Oakley
Ablebond 342-1 (epoxy resin)	Buys and Oakley, Evetts
Uhu Plus (epoxy resin)	Pond
Bostic 7 (epoxy resin)	Pond
Devcon 2-Ton (epoxy resin)	Pond
Cascamite (unknown composition)	Parsons and Curl
Seccotine (unknown composition)	Parsons and Curl
Durofix (unknown composition)	Parsons and Curl
unspecified proprietary materials	Klein, Malone

* Aauthors sometimes cited both a general category of adhesive (e.g. cellulose nitrate based adhesives) and proprietary brands of the general category (e.g. Duco Cememt and HMG). Both the general category and the proprietary brands are listed in the table.

Table 3

Literature Review: Loss Compensation Materials Suggested for Use in Ceramic Conservation/Restoration

Loss Compensation Material*	**Cited By:**
plaster of Paris	Andre, Buys and Oakley, Cross, Evetts, Leland, Parsons and Curl, Pond, Savage
plaster of Paris with polyvinyl acetate emulsion	Evetts
plaster of Paris with gelatin	Cross
pipeclay (unknown composition)	Leland
blanc d'Espagne (whiting/silicate of soda)	Leland
epoxy resin	Andre, Buys and Oakley
epoxy resin with fillers (e.g. kaolin, powdered pigments, marble flower, titanium dioxide, barium sulphate, kaolin, collodial fumed silica, glass microballoons)	Andre, Buys and Oakley, Cross, Everett, Evetts, Larney (1973), Malone, Parsons and Curl, Pond, White
epoxy putty	Buys and Oakly, Cross
polyester resin	Andre, Buys and Oakley, Parsons and Curl, Pond
acrylic resin	Parsons and Curl
polyvinyl adhesive with powder pigments	Andre
polyvinyl acetate resin	Larney (1971), Larney (1973)
polyester resin with fillers (e.g. colloidal fumed silica, ground pigments, glass microballoons)	Buys and Oakley
gesso (various formulas)	Cross, Pond
acrylic dental filling compounds	Cross
Polyfilla (cellulose reinforced plaster of Paris)	Buys and Oakley, Evetts, Larney (1971), Larney (1973), Parsons and Curl
Fine Surface Polyfilla (vinyl acetate copolymer with mineral fillers, thickeners and a biocide)	Buys and Oakley
Barbola (unknown composition)	Cross, Pond
Certofix (unknown composition)	Savage
Fortafix (unknown composition)	Savage
commercial porcelain filling compounds	Cross

Table 3 (cont.) -- Literature Review: Loss Compensation Materials Suggested for Use in Ceramic Restoration/Conservation

Loss Compensation Materials*	**Cited By:**
HXTYL NYL-1 (epoxy resin)	Buys and Oakley
Ablebond 342-1 (epoxy resin)	Buys and Oakley
Devcon 5-Minute Epoxy (epoxy resin)	Everett
Araldite (epoxy resin)	Evetts, Larney (1973), White
Devcon 2-Ton Epoxy (epoxy resin)	Evetts
Epo-Tek 302 (epoxy resin)	Evetts
Milliput (epoxy putty)	Buys and Oakley
Seel-Masta (commercial epoxy with filler)	Pond
Sylmasta White Ceramic Plastic (unknown composition)	Everett
Sculpy (polymer clay)	Everett
Cascamite (resin glue) with plaster of Paris or TiO_2	Parsons and Curl
Seccotine (unknown composition) with plaster of Paris	Parsons and Curl
Isopon (polyester resin/fiberglass)	Pond
Vinagel V. G. 118 and Hardening Putty (unknown compositions)	Parsons and Curl
Technovit 4004A (acrylic resin)	Parsons and Curl
unspecified proprietary compounds	Klein, Yates

* Authors would sometimes cited both a general category of loss compensation material (e.g. epoxy putty) and proprietary brands of the general category (e.g. Milliput). Both the general category and the proprietary brands are listed in the table.

Table 4

Literature Review: Inpainting/Coating Materials Suggested for Use in Ceramic Restoration/Conservation

Inpainting/Coating Materials*	**Cited By:**
ground pigments	Evetts, Parsons and Curl
commercial paints (watercolor, casein tempera, oil paint, acrylic emulsion)	Buys and Oakley, Cross, Evetts, Leland, Malone, Parsons and Curl, Pond, Savage, White
cellulose paint	Savage
commercial enamel paints	Cross, Everett
oil paints in Chintex (stoving enamel)	Larney (1973), White
oil paint in enamel medium	Parsons and Curl
oil paint in glaze medium	Parsons and Curl
ground pigments in Chintex (stoving enamel)	Larney (1973)
ground pigments in Paralac (stoving enamel)	Larney (1973)
ground pigments in varnish (acrylic polyvinyl)	Andre
ground pigments in epoxy resin	Andre
ground pigments in acrylic emulsion	Buys and Oakley
ground pigments in polyurethane	Buys and Oakley
ground pigments in urea-formaldehyde	Buys and Oakley
ground pigments in acrylic solvent systems	Buys and Oakley
ground pigments in Rustins Clear Gloss (polyurethane)	Buys and Oakley, Larney (1973)
ground pigments in PU11 (polyurethane)	Larney (1973)
polyurethane	Cross, Larney (1973)
fingernail polish (cellulose nitrate)	Cross
wax	Andre
U.V. curing epoxy resins	Tennent
Chinaglaze (urea formaldehyde)	Evetts, Tennent
PU11 (polyurethane)	Tennent
PU11 (polyurethane) with matting agent	Larney (1973)
Chintex (stoving enamel)	Evetts, Larney (1973)
Ablebond 342-1 (epoxy resin)	Tennent

Table 4 (cont.) -- Literature Review: Inpainting/Coating Materials Suggested for Use in Ceramic Restoration/Conservation

Inpainting/Coating Materials*	**Cited By:**
Araldite HY951 (epoxy resin)	Tennent
Medset Resin SW (polyester resin)	Tennent
Rustins (polyurethane)	Larney (1973)
Plastogen G (acrylic resin)	Tennent
Sylegard 184 (silicone resin)	Tennent
Acryloid B-72 (acrylic resin)	Tennent
Acryloid B-48N (acrylic resin)	Evetts
Rowney's #800 Clear (picture varnish)	Pond
Cryla Colour (acrylic emulsion paints)	Buys and Oakley
Maimeri Colors (ground pigment in resinous gum)	Evetts
unspecified proprietary materials	Klein, Yates

* Authors sometimes cited both a general category of material (e.g. polyurethane) and proprietary brands of the general category (e.g. PU11). Both the general category and the proprietary brands are listed in the table.

Table 5

Analysis of Materials from *Master Mending Kit**

MATERIAL	MATERIAL TYPE	XRF: ELEMENTS	FTIR: ORGANIC	FTIR: INORGANIC
New Gloss Glaze	Coating Material	Colorless	Acrylic	
Porcelainate Powder	Filler	Zn	Polyvinylacetate	
Pactra Yellow	Enamel Paint	Ti, Fe	not analyzed	Talc
Epoxy	White Finishing Resin	Ca, Ti, Zn	Bisphenol A-Epichlorohydrin Epoxy	$CaCO_3$
Epoxy Putty	Resin and Hardner	Ca(tr)	Bisphenol A-Epichlorohydrin Epoxy	Talc, $CaCO_3$
Epoxygloss	Resin and Hardner	Colorless	Bisphenol A-Epichlorohydrin Epoxy	-----

* The *Master Mending Kit* is a commercial glass and ceramic restoration kit produced by Atlas Minerals & Chemicals, Inc. of Mertztown, Pennsylvania. The instruction booklet which accompanys kit refers the user to *How to Mend Your Treasured Porcelain, China, Glass and Pottery* by L. A. Malone. The kit can still be purchased from Conservator's Emporium, 100 Standing Rock Circle, Reno NV 89511.