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THE USE OF COPYFLEX FOOD GRADE SILICONE RUBBER FOR MAKING IMPRESSIONS OF ARCHAEOLOGICAL OBJECTS

VANESSA MUROS, HEATHER WHITE, AND ÖZGE GENÇAY-ÜSTÜN

Conservators are always looking for stable and inert materials that are easy and safe to use on cultural objects. This is especially true when working in the field, where lab grade facilities and resources are limited, if not inaccessible. In the summer of 2014, conservators at the Ancient Methone Archaeological Project tested a food grade silicone rubber, CopyFlex, to make impressions of ceramic artifacts. The pilot application of CopyFlex in the field, combined with the results of Oddy testing, shows it to be a remarkably viable field tool that reproduces fine surface detail while being simple to prepare, easy to use, and safe for the artifact. This article will describe the material and highlight the advantages of its use in the field with the aim of adding another product to the conservator's tool kit.

KEYWORDS: Archaeological conservation, Silicone rubber, Mold, Food grade, Oddy test

1. INTRODUCTION

Conservators often need to make molds or take impressions of artifacts that are used as replicas to cast and recreate missing areas on an object, or in the case of archaeological conservators working on site, to make copies of artifacts or take impressions for research and publication. Silicone rubber is a material commonly used for molding artifacts and has been successfully used to copy fine details on archaeological objects.

The directors of the Ancient Methone Archaeological Project were interested in taking impressions of objects, such as coins, or possibly molding and casting small artifacts for study purposes since it is not possible to remove archaeological objects from Greece for research purposes. The conservators were tasked with finding a suitable molding material for these purposes. At the suggestion of a colleague, the conservators on the project tested CopyFlex, a two-part room temperature vulcanization (RTV) food grade silicone rubber, for its suitability as a molding material to take into the field. The low cost, ease in mixing, ability to copy fine detail, and low toxicity of CopyFlex made it an appealing alternative to more commonly used low-viscosity molding materials, such as Dow Silastic 3110 RTV silicone rubber, or dental impression materials.

2. COPYFLEX

CopyFlex is a two-part, RTV silicone rubber (organopolysiloxane based) manufactured by Make Your Own Molds. This silicone rubber is a food grade silicone rubber and can be used to make molds for creating food items, but it is also marketed for molding non-food items. The manufacturers describe the material as having a low viscosity, which makes it ideal for replicating fine details.

2.1 WHAT IS FOOD GRADE SILICONE RUBBER?

CopyFlex is described as a food grade silicone rubber and is safe to use to make food molds, such as those used for hard candy, chocolates, or other food items (fig. 1). The Material Safety Data Sheet (MSDS) (Make Your Own Molds 2015a) describes CopyFlex as having low toxicity and a low health hazard. But what exactly is meant by a silicone rubber being "food grade"?

Some other RTV silicone rubbers may contain hazardous ingredients and are not necessarily food grade ingredients as regulated by the US Food and Drug Administration (FDA). However, the ingredients used in CopyFlex comply with the FDA's regulations cited in 21CFR177.2600 (US Food and Drug

Fig. 1. CopyFlex is a food grade silicone rubber that can be used as a mold for different food items, such as the chocolates pictured here. The authors used the silicone rubber to mold a modern glass lion head to make a dark chocolate version of the glass plaque. (Courtesy of Vanessa Muros)

Administration 2014b). This document describes regulations set out for "Food for Human Consumption" and has a section on "Indirect Food Additives: Polymers" (Part 177), which discusses "rubber articles intended for repeated use," such as molds. To be considered food grade, both the elastomer and catalyst must be non-toxic in their uncured state. The silicone elastomer that comprises CopyFlex is on the list of approved materials contained in the regulation ("a silicone elastomer made with methyl and vinyl groups"). The catalyst in CopyFlex, platinum dicarbonyl dichloride, has been approved for use by the FDA as an indirect food additive as long as it does not exceed 150 ppm (or 0.015%) (US Food and Drug Administration 2014a). In CopyFlex, the catalyst makes up 0.01% of Part A (Make Your Own Molds 2015a).

In addition to complying with the preceding regulations, according to the manufacturer, CopyFlex has been subject to extraction testing performed by an FDA-approved and independent laboratory that specifically certifies its suitability for use with water-based foods and also foods that contain fat (Make Your Own Molds 2015b).

2.2 WORKING PROPERTIES

In researching CopyFlex as a potential mold-making material, there were several aspects that made it appealing for use in the field:

- *Easy mixing ratio*: CopyFlex comes in two parts, A and B, and is mixed using a 1:1 ratio of both parts by either weight or volume. This flexible mixing ratio makes it easy to prepare in the field because it does not require the use of a balance for weighing out the catalyst.
- *Shorter curing time*: Unlike other low-viscosity RTV silicone rubbers commonly used for mold making, CopyFlex has a shorter cure time. It cures in 4–5 hours at 70°F.
- *Low cost*: CopyFlex is fairly low in cost compared to other low-viscosity RTV silicone rubbers. A 1 lb. kit costs $25, and the price decreases when larger volumes are purchased. Excavations often run on tight budgets, so it is important to find good-quality and effective materials to use that are low in cost.
- *Low toxicity and low health hazard for user*: Conservation work on archaeological excavations often takes place in makeshift field labs without the proper health and safety controls that would be available in a standard lab. Although personal protective equipment can be used to protect the field conservator when working with toxic materials, ideally it would be best to work with materials that have no or low toxicity. The fact that CopyFlex has low toxicity and is a low health hazard according to the MSDS additionally made it of great interest for testing in a field situation.

2.3 BARRIER MATERIALS: PROTECTING THE SURFACE OF ARTIFACTS

Conservators have often found that the application of silicone rubber to porous materials can result in alteration of the surface. The silicone oils contained in the silicone rubber can leave stains that are difficult to impossible to remove (Larsen 1981; Maish 1994). Silicone rubber can also adhere to porous materials and result in some loss of the surface when the silicone rubber is removed. A surface sealant, release agent, or some kind of barrier layer is often applied to a porous surface prior to application of the molding material to ensure that no damage is caused to the artifact. Materials commonly used by conservators to seal surfaces prior to molding include methylcellulose, resins like Paraloid B-72, and more recently cyclododecane (Brückle et al. 1999; Maish and Risser 2002).

The technical information provided on the use of CopyFlex does not suggest the use of any kind of barrier layer or sealant in regard to this specific product (Make Your Own Molds 2015b). The manufacturers sell a product called *Seal-Dit*, made of a blend of food grade waxes, which is recommended to seal the surface of porous materials prior to the use of any of their molding products to ensure release of the material and no loss to the surface of the object to be molded (Make Your Own Molds 2015c). However, there is no mention of protection needed for possible staining due to silicone oils in the molding material.

2.3.1 Testing

Prior to using CopyFlex on any archeological artifact, the conservators decided to conduct some tests to see if the use of CopyFlex on an unsealed surface resulted in staining and whether CopyFlex would adhere to and remove material from a porous surface. Two resins available on the project were tested as potential surface sealants or barrier layers: Paraloid B-72 and B48-N. Low concentration solutions (3% and 5%) of each resin were tested to ensure that the barrier layer would be thin enough to not obscure any surface detail, but also that it would not darken the porous surface to which it was applied in case not all traces of the barrier layer could be removed after application of CopyFlex.

Table 1. Results of Testing Barrier Materials After Application of CopyFlex and Its Removal After Curing

	Flower Pot Dish	Terracotta Roof Tile	Removal/Damage of Surface
No Barrier	Stained	Stained	Only observed on terracotta roof tile
3% Paraloid B-72	Some staining	Some staining	None
5% Paraloid B-72	No staining	No staining	None
3% Paraloid B48-N	Some staining	Some staining	None
5% Paraloid B48-N	No staining	No staining	None

Staining tests were conducted on a terracotta flower pot dish and a terracotta roof tile. Rectangular areas were marked off on each terracotta object, and the surface was sealed in each area with two coats of each of the solutions, which were prepared in acetone. One area was left unsealed, which was used to test the effect of CopyFlex on the unsealed surface. Once the sealed surfaces dried, CopyFlex was prepared according to the manufacturer's instructions and applied to each test area. Once the CopyFlex cured, it was peeled off the test areas. Visual examination was used to determine if any staining had occurred, comparing unsealed areas and sealed areas before and after application of CopyFlex.

2.3.2 Results

The unsealed areas and the areas coated with the 3% B-72 and 3% B48-N solutions showed signs of staining (table 1). The unsealed areas appeared very dark and the surface was saturated after removal of CopyFlex. Although no testing was conducted to characterize the stains, they were thought to be due to presence of silicone oils in CopyFlex. The test areas sealed with the 3% solutions showed spots of some dark discoloration similar to what was observed on the unsealed areas. The test areas sealed with the 5% solutions showed no dark stains on the surface similar to what was observed on the other test areas and attributed to the silicone oils or silicone rubber residues (figs. 2a, 2b).

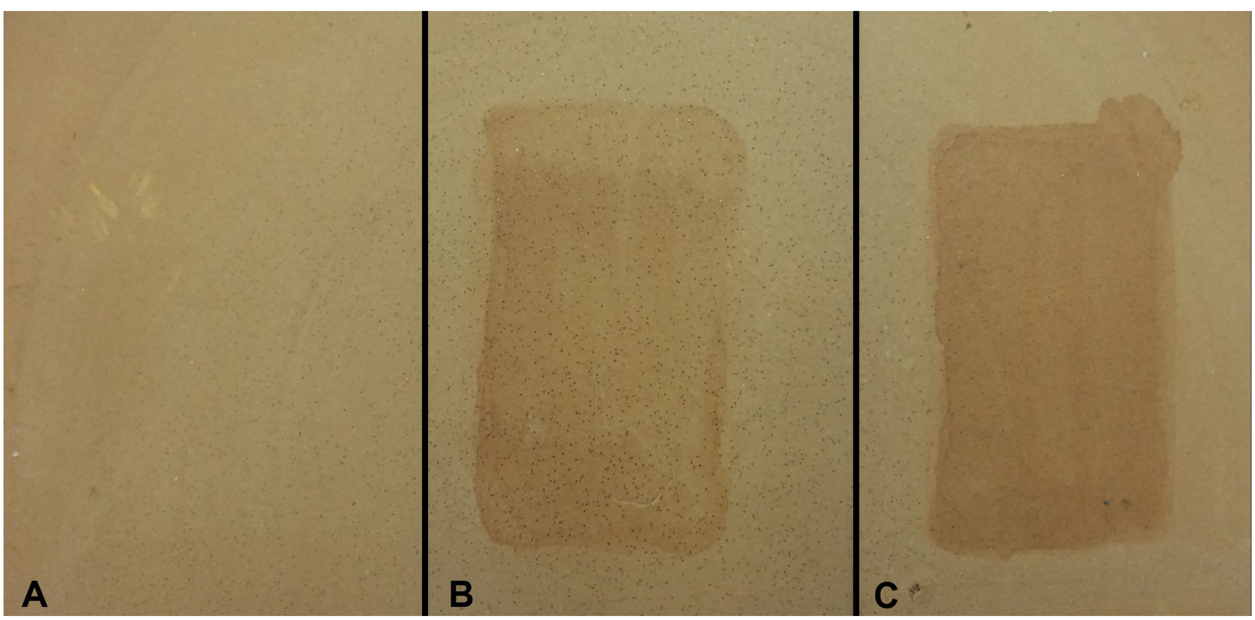

Fig. 2a. Example of one of the staining tests conducted. Here the test areas on a terracotta flower pot dish are documented after the application of a barrier and prior to the application of CopyFlex. Area A has no barrier applied, area B has two coats of 3% Paraloid B-72, and area C has two coats of 5% Paraloid B-72. (Courtesy of Vanessa Muros)

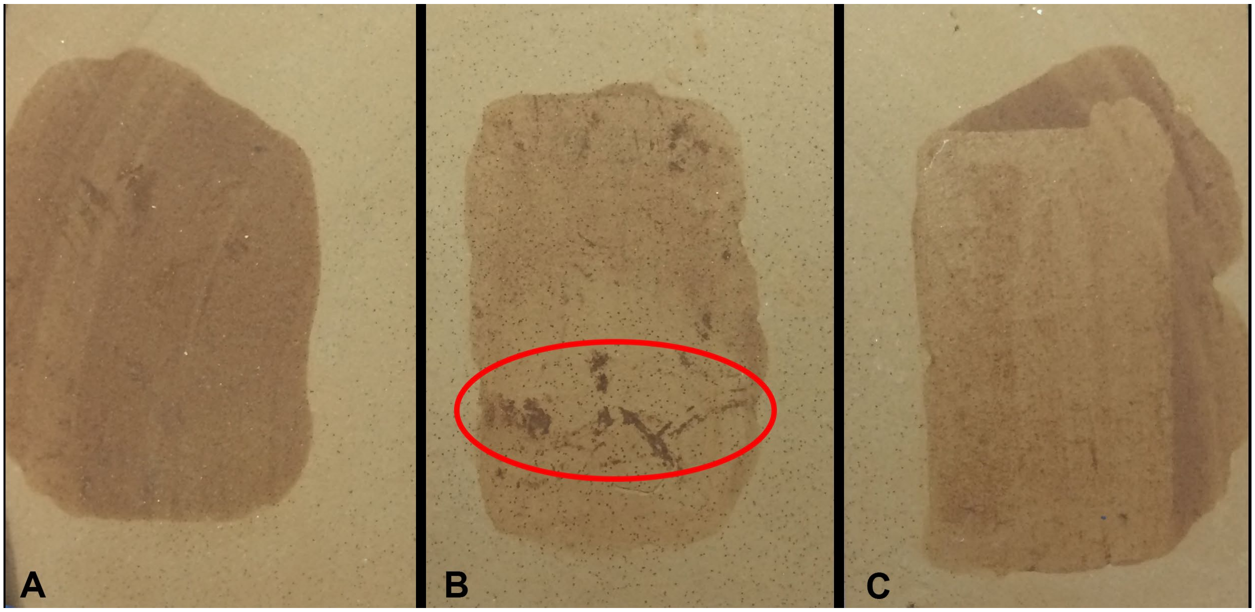

Fig. 2b. Test areas documented in figure 1a after the application of CopyFlex and its removal after curing. Area A (with no barrier) and area B (with a 3% Paraloid B-72 barrier) show some staining from what is likely oils in the silicone rubber. In area B, an example of this staining is marked in red. Area C (with a 5% Paraloid B-72 barrier) showed no signs of staining from the application of the silicone rubber except in the areas around the sealed rectangular section where the silicone rubber ran beyond the test area during curing. (Courtesy of Vanessa Muros)

Based on these observations, it appears that the 5% solution of B-72 and B48-N were both effective in sealing the surface and preventing any staining of the porous materials as a result of the application of CopyFlex.

Because the results of the staining tests relied on visual examination and determination of a color change, it was important to rule out any darkening that could have occurred due to the application of the resin barriers. The test areas that were coated with resin were swabbed with acetone to remove or reduce any of the resin applied. Since silicone oils would not dissolve in acetone, areas that did not change color after swabbing with acetone were assumed to be stained due to the application of CopyFlex and not due to the application of the resin. The areas with no barrier applied did not change color and stayed dark and saturated in appearance. The areas that had the 3% solutions applied had some sections that appeared lighter and others that stayed dark and saturated after application of the acetone. This was interpreted as evidence that some of the dark stains were likely due to staining by silicone oils. The test areas coated with the 5% solutions lightened considerably after swabbing with acetone, and by the same reasoning there did not seem to have been any staining or discoloration due to the silicone oils in those areas.

Test areas with CopyFlex applied were also examined to see if it damaged or pulled up any of the surface of the terracotta test materials (see table 1). Test areas where the surface was sealed, regardless of the concentration of the solution, showed no damage, and the silicone rubber could be removed easily without any observed loss of the surface under visual examination with low magnification. CopyFlex applied to an unsealed area of the flower pot dish peeled off cleanly. However, CopyFlex applied to an unsealed area of the roof tile pulled off some of the surface. The results of this examination show that it is best to seal the surface of porous materials to ensure that no damage or discoloration occurs to their surfaces.

3. CASE STUDY: USE OF COPYFLEX ON THE ANCIENT METHONE ARCHAEOLOGICAL PROJECT

CopyFlex was field tested in the summer of 2014 to make an impression of a rare ceramic figurine mold discovered during a field survey on the Ancient Methone Archaeological Project. The site of ancient Methone is located in northern Greece on the Thermaic Gulf at the delta of the Aliakmon River. It is situated near the modern-day town of Nea Agathopoli. The site shows evidence of occupation from the late Neolithic through the Archaic periods. The site was abandoned in 354 BCE when Philip II of Macedon, Alexander the Great's father, invaded Methone and moved all residents out of the site (Archibald 2012). Methone was never reoccupied, although a Macedonian garrison was built by Philip just north of it.

The object—METH 5582—was brought to the lab covered in concretions that initially disguised the presence of a face and likewise the object's identity as a mold (figs. 3a, 3b). Following treatment and removal of the concretions, the mold was found to be in excellent condition with

Fig. 3a. Before treatment image of exterior, *Figurine Mold*, ca. 6th–5th-century BCE, Ceramic, 5.1 × 4.2 × 3.1 cm, Ancient Methone Archaeological Project, METH 5582 (Courtesy of the Ancient Methone Archaeological Project)

Fig. 3b. Interior of ceramic figurine mold (METH 5582) before treatment. The extensive concretions obscured the recessed face. (Courtesy of the Ancient Methone Archaeological Project)

well-preserved details of the figure's face (figs. 4a, 4b). The discovery of the object as a figurine mold warranted a great deal of excitement, as it is the first Archaic period mold found at Methone. The site shows evidence of manufacturing and production (ceramics, bronze, iron, lead, bone/ivory working, and possibly glass) and contains evidence of extensive trade throughout the Mediterranean (Archibald 2012). The archaeologists and project directors were very interested in making an impression of the mold to compare its details, such as face and hairstyle, with ceramic female figurines found in the area to see if there was a connection between possible production at Methone and distribution of the finished product.

In preparation for making the impression using CopyFlex, the interior surface of the mold was brush coated with a barrier layer of 3% B-72 and 5% B48-N in acetone to mitigate any possible discoloration of the porous ceramic; the decision to add a layer of 5% B48-N was based on preliminary staining tests conducted on a roof tile (see Section 2.3.1). An initial layer of silicone rubber was applied to the sealed surface using a brush to ensure full contact with the recessed facial details (fig. 5).

Fig. 4a. Interior of ceramic figurine mold (METH 5582) after removal of concretions (Courtesy of the Ancient Methone Archaeological Project)

Fig. 4b. Detail of interior of ceramic figurine mold (METH 5582) after removal of concretions (Courtesy of the Ancient Methone Archaeological Project)

Fig. 5. Coating the interior of the mold with a thin layer of CopyFlex (Courtesy of the Ancient Methone Archaeological Project)

PRIMA Plastalina modeling clay (sulfur-free) walls were built around the mold over barriers of plastic wrap; these walls created a well that would contain the silicone rubber as it was poured (figs. 6, 7). CopyFlex was slowly poured into the mold until it reached the top of the clay walls. The following day,

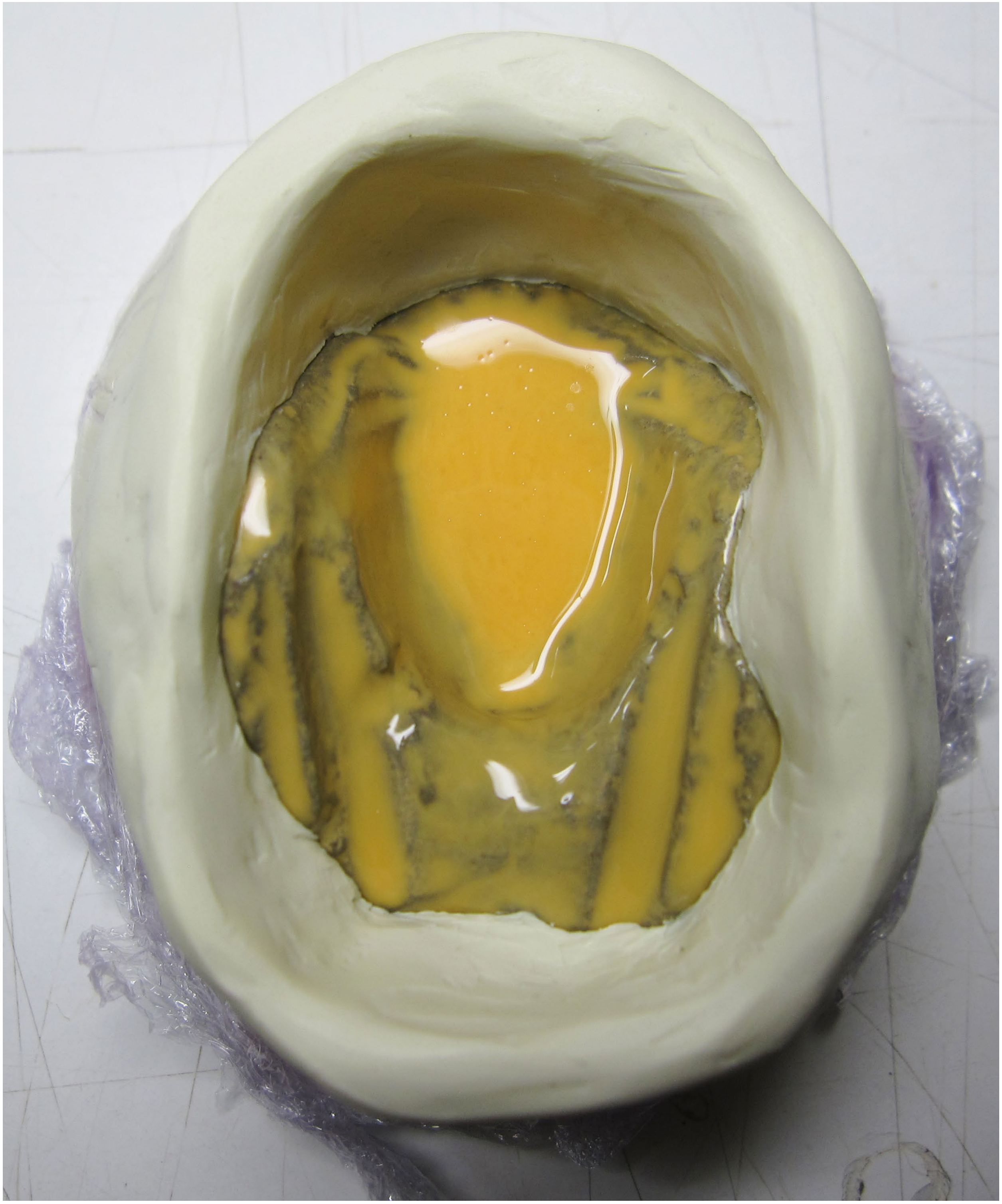

Fig. 6. Modeling clay walls were built around the figurine mold to contain the silicone rubber as it was poured. (Courtesy of the Ancient Methone Archaeological Project)

Fig. 7. Pouring the silicone rubber (Courtesy of the Ancient Methone Archaeological Project)

Fig. 8. After curing, the modeling clay walls were peeled away to reveal the cured CopyFlex, which was then easily removed from the figurine mold. (Courtesy of the Ancient Methone Archaeological Project)

approximately 24 hours after the material was poured, the cured silicone rubber impression was easily removed from the artifact without incident (fig. 8).

The impression accurately reproduced the fine details of the facial rendering, as well as details of the mold's surface condition (figs. 9–11).

Fig. 9. CopyFlex impression of the ceramic figurine mold (Courtesy of the Ancient Methone Archaeological Project)

Fig. 10. Subtle surface details, including losses and other features of the mold's condition on the proper left side of the figure's nose, were accurately represented. (Courtesy of the Ancient Methone Archaeological Project)

Fig. 11. CopyFlex impression and ceramic figurine mold (METH 5582) (Courtesy of the Ancient Methone Archaeological Project)

4. MATERIALS TESTING: ODDY TESTS

CopyFlex is described as a food grade silicone rubber, but it was not clear what this meant in terms of its interactions with artifacts. The natural assumption was that the silicone would not off-gas or cause any damage when in contact with or near archaeological artifacts because it was "food grade." However, at the end of the 2014 season on the Ancient Methone project, the conservators were faced with the question of how to store the silicone rubber impression. They wanted to keep the impression and artifact in the same storage bag but were unsure if any products would off-gas from the CopyFlex, which could be detrimental to the ceramic artifact in an enclosed environment. The conservators decided to isolate each component—the CopyFlex impression and the ceramic figurine mold—in a polyethylene bag for storage but took samples of the cured silicone rubber back with them to conduct Oddy tests on the silicone rubber.

The Oddy test is an accelerated aging test, usually conducted to look at volatile products that off-gas from the test material. In the case of testing CopyFlex, contact tests between the metal coupons and the silicone rubber, as well as testing for off-gassed materials, would be conducted. This would inform not only whether CopyFlex and artifacts could be stored in the same bag or container but also whether they could be in contact with each other.

4.1 ODDY TEST 1: AUTRY

The first Oddy test was conducted with a sample of cured CopyFlex that was the original material used to make the impression in the field. This sample was tested two months after curing. The Oddy test was performed using the test protocol of the Autry Museum of the American West. What follows is a description of how CopyFlex silicone rubber was tested in Autry's conservation laboratories using that protocol.

4.1.1 Coupons

Coupons of copper, silver, and lead, each of 99.98% purity, were prepared for testing. The coupons were cut with scissors to size. The lead and copper coupons were newly cut from their original sheet, but the silver was reused from past Oddy tests. The coupons were of thicknesses outlined in the published protocol (Üstün 2015), with the silver coupon slightly thinner than the published protocol because it had been used repeatedly for other Oddy tests.

Both sides of the copper and silver coupons were polished using fiberglass bristle brushes. The lead coupons were not polished. All coupons were submerged in acetone for five minutes. They were then left to air dry on Mylar film. Gloves were worn during the coupon preparation, as well as throughout the entire test preparation, such as washing the jars and handling the test material until the closed jars were put in the oven, to ensure that there was no contamination.

4.1.2 Glassware

Each piece of Kimax glassware that would be used for testing had already been cleaned after the previous Oddy test. However, before the current test, they were rewashed using Lipsol biodegradable liquid laboratory detergent. After washing, the coupons were rinsed with tap water, followed by an overall wash in distilled water. They were hung on a laboratory rack for air-drying.

4.1.3 Oddy Test 1: Preparation

All three coupons were inserted in a 1-g sample of the cured CopyFlex, which was then placed inside a 20-mL beaker. Half of each coupon was inserted into the silicone rubber so that half

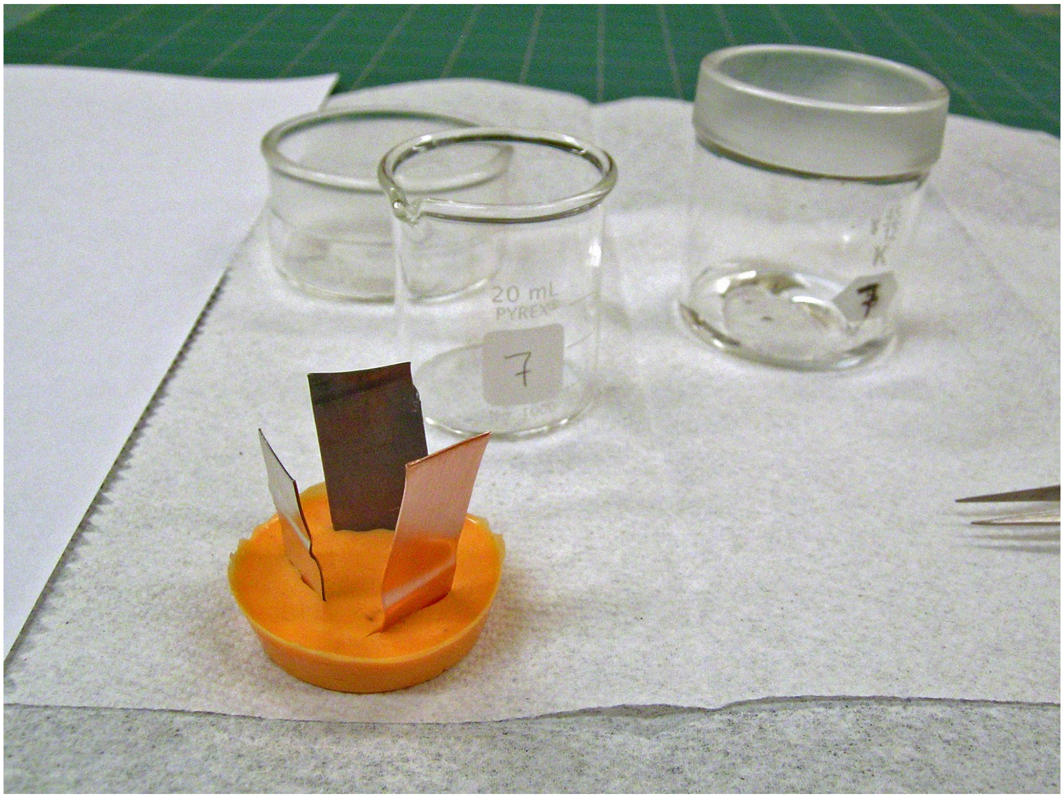

Fig. 12. Detail of the coupons tested with the cured CopyFlex (lower half in contact) before the Oddy test (Courtesy of Özge Gençay Üstün)

the coupon was in direct contact with the material during testing and the other half would maintain contact with any vapors that off-gassed (fig. 12). Kimax weighing jars were filled with 1 mL of distilled water that had a pH of 4.5–5. The beakers containing the samples were lowered inside the Kimax jars. For the control jar, the coupons were bent over the mouth of the 20-mL beaker. A thin layer of Dow Corning silicone vacuum grease was applied inside the lid (on the ground glass part) to tightly close the jars.

4.1.4 Testing Specifics

The test lasted for 28 days in an oven that maintains 60˚C within ±3˚C fluctuations. Inside each jar, 1 mL of water was added to maintain the 1:70 water to container volume ratio (Bamberger et al. 1999). This ensured that relative humidity (RH) was maintained at 100% inside the test jar for the duration of the test. If there was excess water inside the container, condensation did not build up on the coupons because the coupons had been inserted into the test material and stood vertically to prevent water from pooling on them (see fig. 12).

4.1.5 Assessing the Results

According to the Autry protocol, two conservators look at the coupons independently of each other and without knowing what material is being tested. Then they discuss their separately submitted Oddy test results about each material and compare them to each other. During this discussion, the material being tested, its use, and the duration of use are taken into consideration before the final results are agreed upon.

Fig. 13. Results of Oddy test 1 showing the test coupons and the control (Courtesy of Özge Gençay Üstün)

4.1.6 Oddy Test 1: Results

After completion of the accelerated aging, the jars were removed from the oven and test coupons were compared to the control coupons. The section of the coupons inserted into the cured CopyFlex showed similar corrosion patterns to the coupons exposed to vapors, as well as to the control (fig. 13). Based on the results observed, this sample of CopyFlex showed no alteration to the coupons in the contact or vapor testing. Two conservators independent of each other concurrently deemed CopyFlex suitable to be near or in contact with artifacts.

In addition, the pH of the water in the test jar and the control jar was remeasured (6 and 5.5–6, respectively) immediately after the test was concluded. This slight rise of the water pH in the control jar has been previously observed in many other past Oddy test control jars conducted on other materials. The pH of water inside the CopyFlex jar was no different from the one in the control jar in this instance.

4.2 ODDY TEST 2: GETTY VILLA

The second Oddy test was conducted at the UCLA/Getty Conservation training labs at the Getty Villa in Malibu, California, using the Getty Conservation Institute's Oddy testing protocol (Schiro 2015) with some modifications. The materials tested included Part A and Part B of the CopyFlex liquid silicone rubber, as well as a cured sample of the material freshly after mixing. The interest of this test was to gauge the potential of any initial off-gassing within the first day of curing—more relatable to the time frame of when a cast impression or replica might begin to be stored with the artifact—as well as any reaction that may correspond to one of the individual components. In addition, a partial contact test was again utilized for the cured sample—half of the coupon in direct contact and half in contact with any vapors, as it is important to know whether CopyFlex replica can be kept safely in the same enclosure or in contact with an artifact.

4.2.2 Coupons

Coupons made from copper, silver, and lead foil (all of least 99.9% purity), of varying thicknesses, were prepared for testing. The coupons were cut with scissors to size. The copper and silver coupons were polished with precipitated calcium carbonate and deionized water using cotton swabs. They were then rinsed with deionized water and submerged in Mr. Clean liquid cleaning solution (leaves no residue). When removed, they were scrubbed with a stiff-bristle brush and Mr. Clean in the palm of a gloved hand. Finally, they were rinsed thoroughly with deionized water, briefly submerged in acetone, and allowed to air-dry. The lead coupons were not polished or cleaned, although they were submerged in acetone.

4.2.3 Glassware

Each piece of glassware was cleaned using Mr. Clean and then rinsed with tap water followed by washing with deionized water. Last, the glassware was sprayed with acetone and allowed to air-dry.

4.2.4 Oddy Test 2: Preparation

All three coupons were inserted vertically into a small block (approximately 2 × 2 × 1.5 cm, weighing 4.52 g) of cured CopyFlex, which was then placed into a 20-mL beaker. The half of the coupon inserted into the block would be for contact testing, and the other half extending above the silicone rubber sample would be for vapor testing. Liquid components Part A and Part B (each weighing approximately 2.2 g) were poured into their own 20-mL beaker, with coupons bent and hooked over the edge of the beakers (fig. 14). A glass vial filled with 1 mL of deionized water and capped with a perforated plastic lid was placed alongside each beaker in a Kimax ground-glass jar with lid. Teflon tape was wrapped around the ground glass to create a fitted seal between the jar and lid. Gloves were worn at all times throughout test preparation.

4.2.5 Testing Specifics

The test was run against a control for 28 days in an oven maintained at 60°C ± 2°C. To ensure that 100% RH stayed constant for the duration of the test, 1 mL of deionized water was added to the glass vials as needed if evaporation occurred.

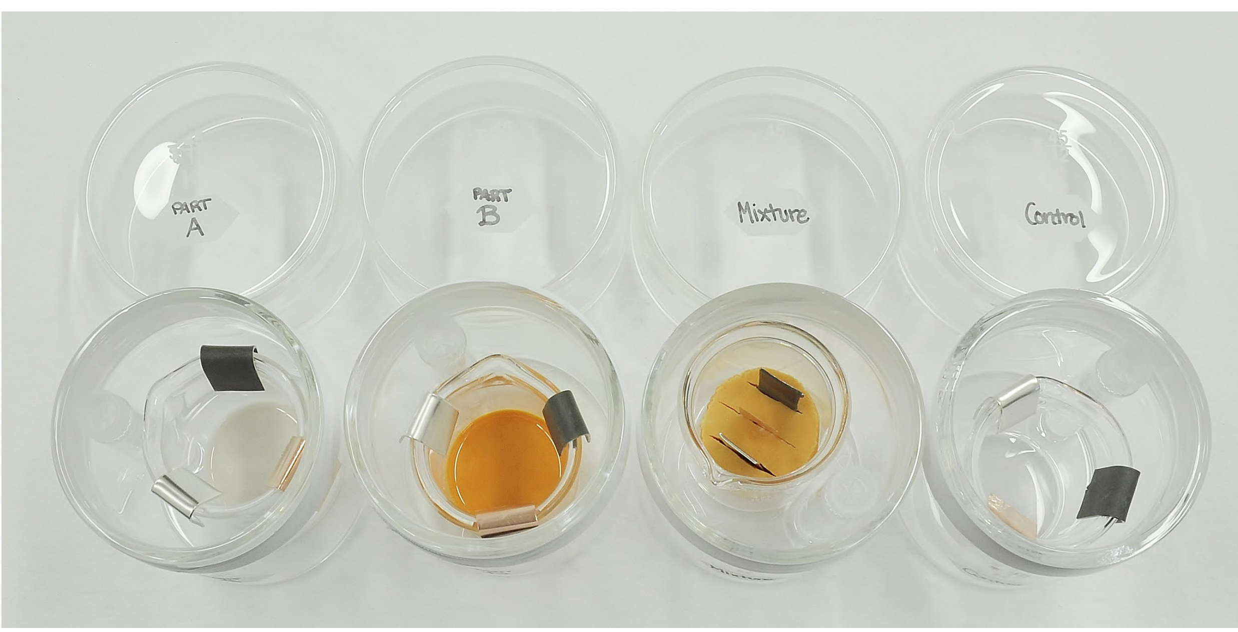

Fig. 14. Oddy test jars ready to be sealed and placed in the oven (Courtesy of Heather White)

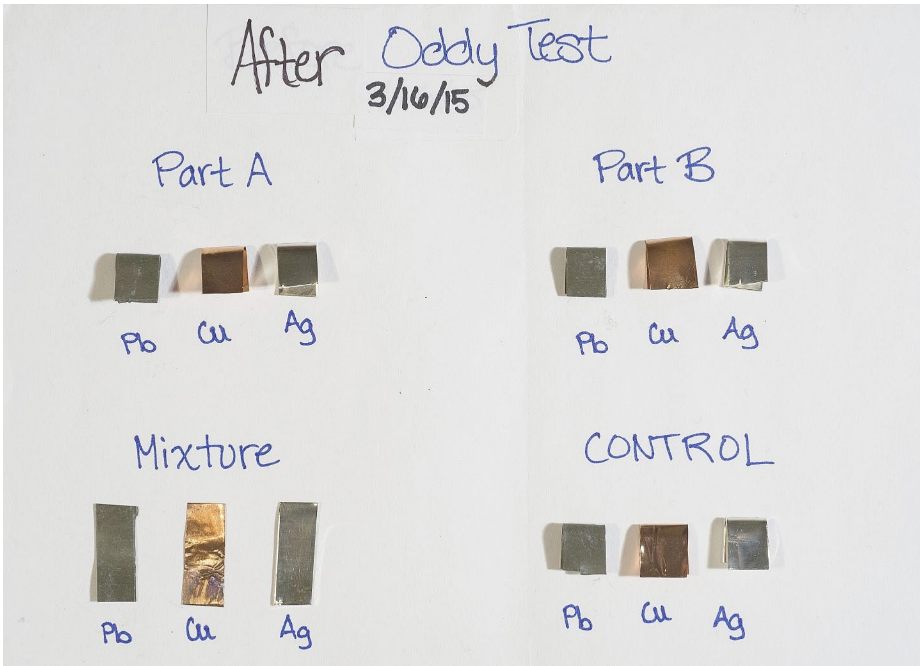

Fig. 15. Results of Oddy test 2 showing the test coupons and the control (Courtesy of Heather White)

4.2.6 Oddy Test 2: Results

All coupons used for the vapor tests showed a negligible amount of tarnishing corresponding to the same seen on the controls. The results for the contact test, however, were different. Although the silver and lead coupons in contact with CopyFlex looked the same as the controls, a great deal of surface change was observed on the copper coupon inserted into the cured silicone rubber (figs. 15, 16).
To confirm these results, the Oddy test was replicated and again resulted in the reaction of the copper

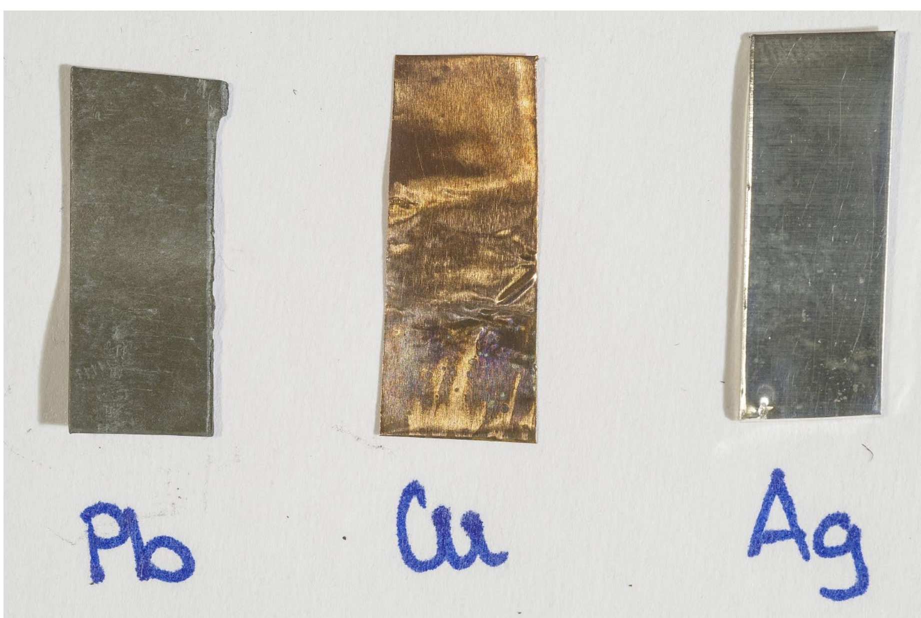

Fig. 16. Detail of the coupons tested with the freshly cured CopyFlex. Note the changes to the lower half of the copper coupon. (Courtesy of Heather White)

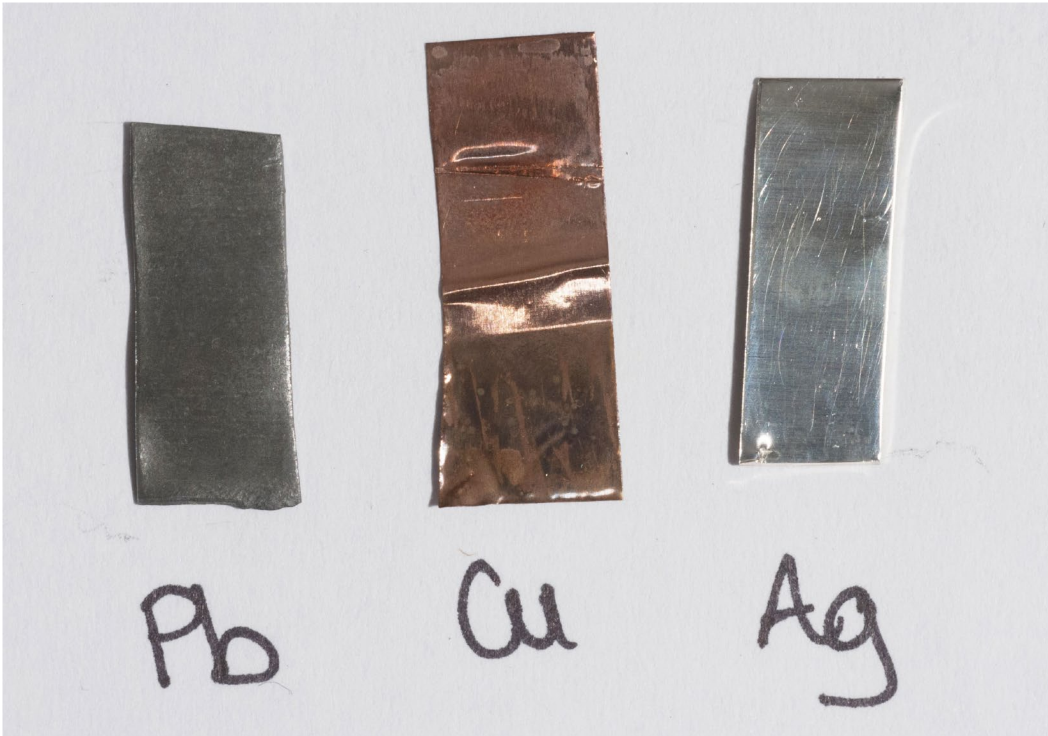

Fig. 17. Results of the replicated Oddy test on the freshly cured CopyFlex showing corrosion on the copper coupon (Courtesy of Heather White)

coupon (figs. 17, 18). The part in contact with the silicone rubber corroded to a purple color with silvery spots, and the upper part of the coupon exposed to vapor showed notable tarnishing greater than what was seen on the rest of the copper tests.

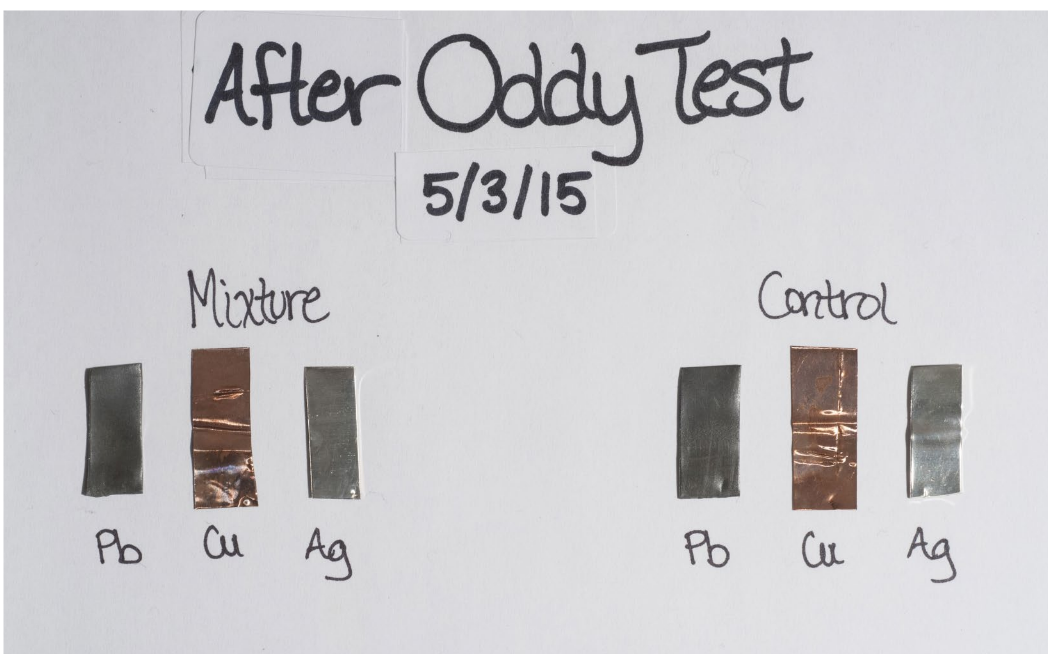

Fig. 18. Detail of the test coupons from the replicated Oddy test showing the corrosion on the copper coupon (Courtesy of Heather White)

4.3 DISCUSSION: ODDY TEST RESULTS

Based on the results of the Oddy tests conducted, it appears that freshly cured CopyFlex corroded the copper coupons during the contact tests and may therefore not be suitable to be stored in contact with archaeological artifacts, at least not copper alloy–based materials. No vapors, however, off-gassed from the freshly cured silicone rubber, and therefore it may be suitable to store objects in proximity to CopyFlex molds/impressions.

CopyFlex testing after several months of curing did not corrode any of the coupons either in the contact or the vapor test. Based on these results, the silicone rubber would be suitable to be stored in proximity or in contact with artifacts two months after the initial cure.

5. CONCLUSIONS AND FUTURE WORK

Based on the field trials, CopyFlex seems to be a low-cost, viable, and effective alternative to other RTV silicone rubbers used for mold making. This silicone rubber is easy to use, has a relatively short cure time, and has low toxicity to the user. CopyFlex successfully made an impression of a ceramic figurine mold found during a survey on the Ancient Methone Archaeological Project, reproducing the mold in fine detail and thus allowing the artifact to be studied and photographed for publication. Because of the success the conservators had with the material in the 2014 field season, the project conservators will continue to use CopyFlex for any future mold making required during the excavation season. Until further Oddy testing can be conducted, any future molds or impressions made will be isolated from any of the artifacts in storage.

Oddy testing will continue to be conducted on CopyFlex to understand the changes observed on the copper coupons during this study. Testing the silicone rubber at different intervals after the initial cure to see how that affects the results of the Oddy test will be undertaken. Further investigations will be conducted using both testing protocols to see if that had an effect on the different results obtained during the contact Oddy tests. Work will focus on the corroded copper coupons to see if the changes observed can be characterized to understand what could have caused the changes to the test coupon.

The excellent results achieved with CopyFlex in the field has encouraged the head conservator on the Ancient Methone project to investigate another material manufactured by Make Your Own Molds: a more viscous, food grade mold-making material known as Silicone Spread (Make Your Own Molds 2015d). The paste-like consistency of this material could allow it to be used for mold making on vertical surfaces and as a low-cost alternative to the use of heavy-body dental impression materials such as Reprosil (vinyl polysiloxane). The conservators on the project will also test the efficacy of cyclododecane as an alternative barrier material/sealant based on its successful use as a barrier, as published by Brs pub et al. (1999) and Maish and Risser (2002).

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SOURCES OF MATERIALS

Copper foil, Cu000690 (used for Oddy test 1) (99.98%, 0.3 mm thick, #410-528-44), lead foil, PB000400 (99.95% purity, 0.5 mm thick, #474-046-72)

GoodFellow Limited
125 Hookstown Grade Rd.
Coraopolis, PA 15108-9302
http://www.goodfellow.com/

Copper foil (used for Oddy test 2) (99.98% purity, 0.25 mm thick, #349178-49.5G), silver foil (used for Oddy test 1) (99.98% purity, 0.005 in. thick)

Sigma-Aldrich Corp.
3050 Spruce St.
St. Louis, MO 63103
http://www.sigmaaldrich.com/

CopyFlex

Make Your Own Molds
7609 Production Dr.
Cincinnati, OH 45237
http://www.makeyourownmolds.com/

Dow Corning High Vacuum Grease (5.3 oz. tube #14-635-5D), Fisherbrand Autosampler Shell Vials (1 mL #03-391-23), Kimax Borosilicate Weighing Bottles with Ground Glass Outside Caps (45 mL, 40 × 50 mm, 45/12 #03-422F), Kimax Griffin Beakers (20 mL #02-539-1), Lipsol Detergent

Fisher Scientific
300 Industry Dr.
Pittsburgh, PA 15275
800-766-7000
http://www.fishersci.com/

Industrial Fine Eraser E113/F (metal body fine FybRrglass eraser) #AA2120

The Eraser Company Inc.
PO Box 4961
Syracuse, NY 13221-4961
315-454-3237
http://www.eraser.com/

Mr. Clean Multi-Surface Liquid Cleaner

Proctor & Gamble
1 P&G Plaza
Cincinnati, OH 45202
http://www.mrclean.com/en_US

Paraloid B48-N, Paraloid B-72
Conservation Resources
5532 Port Royal Rd.
Springfield, VA 22151
http://www.conservationresources.com/Main/S%20CATALOG/default.htm

Precipitated calcium carbonate
VWR
100 Matsonford Rd.
Radnor, PA 19087-8660
http://us.vwr.com/

PRIMA Plastalina Modeling Clay
Blick Art Materials
PO Box 1267
Galesburg, IL 61402-1267
http://www.dickblick.com/

Silver sheet (used for Oddy test 2) (99.9% purity, 24 gauge (0.020 in. thick) Fine Silver, 6 × 12 in., SI8370-6X12)
Metalliferous
34 W. 46th St.
3rd Floor
New York, NY 10036
http://www.metalliferous.com/

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