



Introduction

The archaeological conservation of highly perishable organic matter has always been problematic. In 1996, for example, the Texas Historical Commission began excavating René-Robert Cavalier, Sieur de La Salle's vessel, *La Belle*, which sank off the Texas coast in 1686. The recovery of this vessel has presented a host of unique challenges in conserving wood, basketry, leather, and an assortment of supplies necessary to start a colony in the New World. Entombed in the mud that sealed it from decay for more than three centuries, the waterlogged hull and hundreds of thousands of fragile artifacts, including brain matter in the skull of one unfortunate sailor, would have been a futile conservation effort without new preservation technologies.

The aim of this book is to help conservators develop successful treatment strategies for organic materials using Passivation Polymers. These polymers are part of a series of chemistries and techniques developed at Texas A&M University to provide efficient and cost-effective conservation strategies for the purpose of archaeological preservation. Museums and historical societies have expressed the need for durable artifacts used in traveling exhibits and interactive displays. In many cases, traditionally treated artifacts cannot withstand the rigors of extended traveling and handling. Passivation Polymer-treated artifacts are more stable than their counterparts preserved using older technologies and can withstand sensible handling extremely well. These preservation processes are not a panacea for all artifacts, but the ease

with which many of these techniques can be used makes them viable for various conservation challenges and for laboratories working with limited budgets.

In addition to discussing the advantages offered using Passivation Polymer technologies and materials, I consider a concept seldom addressed in conservation: artistry. Variance in equipment, relative humidity, laboratory layout, intended end results, and level of expertise are a few variables that play an important role in the development of preservation strategies and protocols that work for each technician. The key to consistent and aesthetically correct samples using Passivation Polymers, and indeed all conservation materials, is a willingness to explore treatment parameters and combinations of polymers.

In chapter 1 the Archaeological Preservation Research Laboratory at Texas A&M University is used as a model to illustrate an effective layout for day-to-day conservation of small organic artifacts using polymers. Too often, the entire working budget of a conservation facility is spent in the acquisition of elaborate equipment. This is a shame since well-trained conservators should be the first consideration of any laboratory. Accordingly, a short list of essential instrumentation is discussed in chapter 1. The distinction is made between equipment needed for conservation of artifacts and equipment and necessities for the purpose of research and development; small necessities and chemicals are also discussed. While conducting postdoctoral research at

Dow Corning Corporation, I learned from professionals how to work effectively and economically in the laboratory. Since it seems that all archaeological projects are underfunded and understaffed, these cost-saving suggestions can remove some of the economic stresses involved in outfitting a conservation facility.

Chapter 2 examines some of the mechanical processes used for Passivation Polymer processing of organic materials from marine and land sites. Two experiments are provided to demonstrate water/solvent and solvent/polymer exchange processes that are fundamental to many of the experiments and case studies throughout the book. In “Dowel Experiment,” penetration depth of polymers and the presence of water in organic materials are discussed. The experiment illustrates the relationship between solvent dehydration and time in the treatment of wood. A second experiment, “Mass Spectrographic Analysis of Out-Gases Created from the Dehydration of Archaeological Wood Samples,” illustrates the differences in exchange potential of organic artifacts that have been dehydrated using a single solvent dehydration process as compared to combined solvent processing.

Chapter 3 discusses the preservation of wooden artifacts using Passivation Polymers and is divided into two sections: waterlogged wood and dry-site artifacts. Bacteria, fungi, and the loss of structural integrity can be caused by waterlogging or desiccation from extreme dryness. Regardless of the object’s archaeological provenance, stabilizing archaeological wood is a great challenge for the conservator. Mechanical destruction caused by freeze-thaw cycles in lakes, swamps, and bogs may act to accelerate the degradation of wood. Regardless of what type of degradation has occurred in a wooden artifact, Passivation Polymer technologies have proved effective in preserving diagnostic attributes.

Conservators face another challenge: museums around the world are filled with artifacts, big and small, that were preserved us-

ing polyethylene glycol (PEG) methods. Conserved during a time when PEG technology was new, these artifacts have not fared as well as artifacts preserved using the well-defined PEG treatment strategies developed in the latter half of the twentieth century by Per Hoffmann, David Grattan, and others. Re-treatment strategies developed to stabilize these difficult artifacts are discussed in a section entitled “Reprocessing and Stabilization of PEG-Treated Wood” and in the case study, “The Re-treatment of Two PEG-Treated Sabots.”

New wood treatment strategies using self-condensing alkoxy silane polymers are covered in another case study, “Treatment of Waterlogged Wood Using Hydrolyzable, Multifunctional Alkoxy silane Polymers.” These treatment strategies enable the conservator to successfully preserve waterlogged wood by introducing an alkoxy silane that, in the presence of atmospheric moisture, self-condenses to form polymers that accurately maintain the diagnostic attributes of waterlogged wood.

Numerous approaches and suggestions for the preservation of waterlogged and desiccated leather are outlined in chapter 4. Case studies are offered to demonstrate the adaptability of the baseline treatment process to accommodate even badly fragmented and desiccated artifacts. Important considerations for the storage and display of leather artifacts are also covered.

One area of great concern for all conservators is the treatment of composite artifacts. Often, it is necessary to disassemble an artifact into its component parts prior to treatment. However, this can damage fragile portions of the artifact. Additionally, structural changes in one or more components of the artifact often make the reassembly stages of conservation difficult. In chapter 5 the case study “Preservation of a Composite Artifact Containing Basketry and Iron Shot” details how wicker basketry was stabilized prior to removing heavy layers of concretion

encasing the basket of shot. After the basket was processed in stages, the iron shot that had been removed from the basket were preserved using electrolytic reduction. The ease with which calcareous material was removed from the surfaces of the iron shot and the resultant treatment of the iron suggest that exposure to Passivation Polymers may have acted to preserve the iron, arresting surface exfoliation and pitting up to, and during, treatment.

Preservation of cordage and textiles from marine and land sites is discussed in chapter 6. Numerous conventional treatment strategies adapted for use with polymers are illustrated in a series of case studies.

It has been argued that glass is not an organic substance. While this is true, fluxes used in the making of ancient glass are organic materials, which accounts, in part, for the unique chemical structure of ancient glass. Treatment methods, accelerated weathering testing, and scanning electron microscopic analysis of polymer-treated glass are presented in chapter 7. Several case studies illustrate the abilities of alkoxysilane materials to stabilize badly deteriorated glass. Treatment techniques used for preserving extremely thin sections of onion bottle glass are discussed to illustrate the degree of creativity that can be employed in the treatment of friable objects. Like polyvinyl acetate and other traditional treatment strategies, reversibility of these treatment methods remains an issue. Data from accelerated weathering and nuclear magnetic resonance imaging experiments indicate that such glass remains remarkably stable much longer than glass treated using conventional methods.

A discussion of ongoing research in the preservation of badly deteriorated ivory and bone from marine and terrestrial sites is the focus of chapter 8. In one case study treatment strategies applied to the preservation of finely carved ivory from the Tantura Lagoon excavations in Israel are discussed. Another case study illustrates methods used to

preserve sections of ivory tusk from a shipwreck off the coast of Australia.

In chapter 9 I explore some of the new tools and technologies that can help conservators devise more effective conservation strategies. Until recently, the conservation process has been hindered by the inability of traditional radiographs to supply sufficient data to give the conservator a complete view of an artifact concealed in a concretion. Through computerized tomography (CT) and computer-aided design (CAD), however, three-dimensional models of artifacts can be created using laser-driven polymerization of each “slice” of CT data. Stereolithography is another technology that is discussed.

Many conservation materials, considered part of the conservation tool kit, are polymers. Research has shown that these materials, once thought to be reversible, have a tendency to cross-link with the organic substrate of the artifacts they were intended to stabilize. While most of us tend to visualize chemists in white lab coats when we think of cross-linked polymers, the process of cross-linking is a natural process. As archaeological chemistry plays an ever-increasing role in our discipline, research scientists and conservators alike will see the expanding role of polymers in archaeological conservation. The polymer chemists who helped define the initial mechanisms at work in Passivation Polymer processes found the task of adapting their thinking to fit archaeological perspectives challenging. Though new terms will inevitably find their way into the conservation lexicon, I have tried to keep the use of new terminology to a minimum in this book.

Experience at the Archaeological Preservation Research Laboratory (APRL) at Texas A&M University has taught us that while complete reversibility of conservation treatments is desirable, it is a state that is sometimes easier philosophized than realized. Retreatability may be a more realistic end goal when determining suitable conservation methods for any given artifact.

The experiments and case studies offered in this book have proved successful for the preservation of a wide range of artifacts. I hope these materials give the reader a broad understanding of how Passivation Polymers, and other silicone oils, may be used for the preservation of organic artifacts. Because no two pieces of wood are exactly alike, selected treatment strategies must be adapted to treat artifacts on a case-by-case basis. Polymer-based materials offer the conservator infinite combinations of material, so that the preservation needs of individual artifacts can be addressed.

Anyone experienced in the complexities of field conservation would agree that artifact triage and stabilization play a major role in the eventual state of an artifact. Passivation Polymers allow the conservator to stabilize friable materials in the field so they can be more easily transported to the laboratory, where continued preservation can be undertaken. Polymers can help stabilize artifacts, even if more traditional conservation methods are used once the artifact is secured in the laboratory.

Invariably, success in using any conservation strategy requires patience and a marriage of technical and artistic know-how. Therefore, time should be spent experimenting with baseline processes before attempting conservation of artifacts. There is no substitute for hands-on experience, which allows the conservator to better understand how to use polymers in the preservation of organic material culture and how these treatments can be adapted to suit each artifact. This type of experimentation will also help the conservator understand and better utilize the equipment used for silicone oil preservation.

The goal of this research has been to fuel new dialogues in conservation and to encourage research along new avenues. Most important, this research encourages the reader to gain a new understanding of the material culture we strive so hard to preserve. The development of polymer chemistry for use in archaeological conservation is in its infancy. To date, development of Passivation Polymers has helped bring new perspectives to bear on the treatment of organic artifacts.