Preventative Conservation of Samurai Armor

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Abstract
This white paper will identify the textile materials commonly used in Samurai armor, describe how they deteriorate over time, and outline protocols for preservation.

Introduction
Renowned for its craftsmanship and beauty, Samurai armor *(katchu*) presents the unique juxtaposition of elegance and power conveyed by its form and function. For armor to work properly it must combine protective materials—such as lacquered steel and iron, or mail—with flexible materials—mainly silk, hemp and leather—to allow movement while guarding the vulnerable areas of the warrior's body. These disparate materials pose unique challenges to the preservation and safe display of Samurai artifacts. Over time, the textile components will deteriorate more rapidly than the metal elements, and will become increasingly vulnerable to the strain and abrasion the more rigid materials place upon them.

Textiles in Samurai armor
Textiles have many unique qualities that make them essential components of samurai armor. They are malleable and may take many forms such as a hide, woven fabric, or braid. They can be soft and provide protection or padding beneath the metal armor. They also can be dyed a range of colors to afford distinction.

Some of the more common elements of Samurai armor found in western collections include the *kabuto* (helmet), *do* (cuirass), *kote* (sleeves), *sode* (shoulder guard), and *haidate* (thigh cover). The style and composition of each garment evolved significantly from the medieval to modern times. Some changes were in response to the evolution of warfare; for example, 10th-century armor changed to meet the needs of a warrior on horseback using a bow and arrow. Other changes reflected historical social and economic trends as well as influence from European travelers. Significant changes in Japanese armor occurred in the 16th century when the Portuguese, Spanish, and Dutch trade routes opened. A new material, mail (often redundantly called chain mail), was introduced by Europeans at this time. What remains relatively consistent is the essential combination of hard and soft materials; these two sets of elements must work in harmony for the armor to succeed.

Fig. 1. In this detail of the inside of a *kote* we see several kinds of textile materials: leather lining and trim; a floral brocade of silk and metal-wrapped silk threads; a blue hemp lining fabric; and silk lacing and braid.

The five main textile materials used are hemp, cotton, silk, metal-wrapped silk, and leather (fig. 1). Silk threads were produced by unwinding the cocoons of the silk worm (Bombax Mori) which is fed exclusively on mulberry leaves. It could be spun into the thread used to weave fabric or create braided lacings, or it could be wrapped with thin metal strips to create metallic thread. Hemp is a vegetable fiber derived from the long stem fibers of the Cannabis Sativa L. plant. Cotton fibers come from the seed pod of varieties of the cotton plant *Gossypium.* Hemp has a longer, thicker staple than cotton, which makes it more durable. Doe skin is the most common type of leather encountered, though the use of horse or dog skin is also documented (Kózan p. 122). Leather was often embossed or lacquered—heavily lacquered leather is rigid enough as to be easily mistaken for metal.

The *kabuto*, or helmet, is typically made of iron and is often lined on the interior with a textile that pads the crown and prevents the inside of the metal bowl from sitting on the head. This textile, called an *ukebari,* is often made of hemp covered with silk (fig. 2). Dark blue hemp was preferable in older armor, and a silk crepe became more popular in the 18th century.

From the *Muromachi* period (1336–1573) onward the sleeve protector, or *kote,* was made of hemp and silk to which iron plates or mail may be sewn (fig. 3). The body of the sleeve was made of a rough hemp plain-weave, which may be waterproofed by soaking it in unripe persimmon juice. Later on *kote* were faced with soft leather or silk damask with yellow being the preferred color. Regardless of the chosen fabric, it should be a single piece of extra-wide cloth to prevent patching. The edging of the sleeve was generally trimmed for durability and may utilize animal skin for this purpose. To close the sleeve around the arm, it was laced up the inner arm with single or double ties, with colors and elaborateness that reflected the owner's preference.

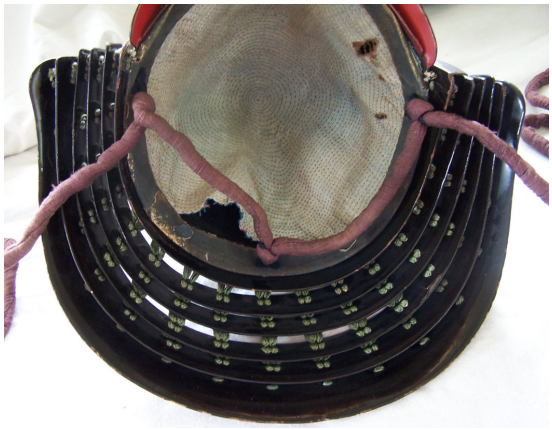

Fig. 2. This *ukebari,* or helmet lining, has been opened in search of a manufacturer's mark. If one is found, the lining will typically be stitched to allow a window through which the mark can be seen. The term for the quilted spiral pattern seen on this *ukebari* is *momo (haiku)-ye-zashi*, or "many stitches."

The *haidate* is a bifurcated apron that provided protection to the thighs. Tied around the waist with a fabric cord, it sometimes also buttoned beneath the leg for extra security. It could be made simply with materials such as lacquered leather and hemp, or it may be armored with mail or small plates sewn to fabric. The *haidate* needed to bend with the wearer's legs, so even an armored model generally had just fabric near the top where it came up over the abdomen (fig. 4).

Shoulder guards, called *sode*, are hinged in such a way that allows them to flex while holding them away from the moving arm. The system of lacing makes the shoulder guard both functional and highly ornamental. An illustration from Kózan shows an 18th-century armorer making final adjustments to a *sode* (fig. 5).

The largest element of a Samurai's armor is the *do*, which covered the torso. Made with metal plates called *kozane*, the *do* could have very few textile components or it could be highly engineered and ornamented. The most elaborate *do* found in collections are those composed of metal scales connected by a network of silk lacings called *odoshi.* A more economical form of *do* could be made of plates of metal connected by countersunk rivets with none of the more elaborate lacing and scales. In some cases the metal plates were even designed and lacquered to imitate lacings. At times of heavy warfare when many men were amassed to fight, armor is by necessity made with less lacing (fig. 6). Changes in lacing reflect not only fashion and finances but also the evolution of weapons as with the introduction of the spear.

Throughout history, lacings remain the popular choice because they are functional and allow for individual expressions of color and style. The term comes from the verb *odosu* (to frighten) because of its role in creating an intimidating appearance for the warrior. It was made of braided silk, sometimes with a core of cotton. The production of lacings was a specialized industry. The 18th-century Japanese author Sakaki Kōzan states "the *odoshi* colors should be carefully selected in accordance with the divinatory laws of *sōshō* (sympathy) and s*ōkuku* (antipathy) else it will bode ill for the wearer" (p. 130). In an oft-quoted passage Kōzan also refers to the disadvantage of too much lacing, which becomes heavy and smelly when wet, and if it freezes may trap an arrow rather than allowing it to bounce off. This conjures up tragic-comedic images of a boastful soldier who is betrayed, rather than saved, by his overly opulent armor (p. 87).

Fig. 3. The silk and hemp textiles on this *kote* are in good condition. The mail has rusted but the more heavily lacquered metal on the hand has not.

Fig. 4. A pair of *haidate*, or thigh protectors. They are connected to a cord wrapped in blue silk that was tied around the warrior's waist. Toggles were inserted into buttonholes to secure the armored section to the thigh.

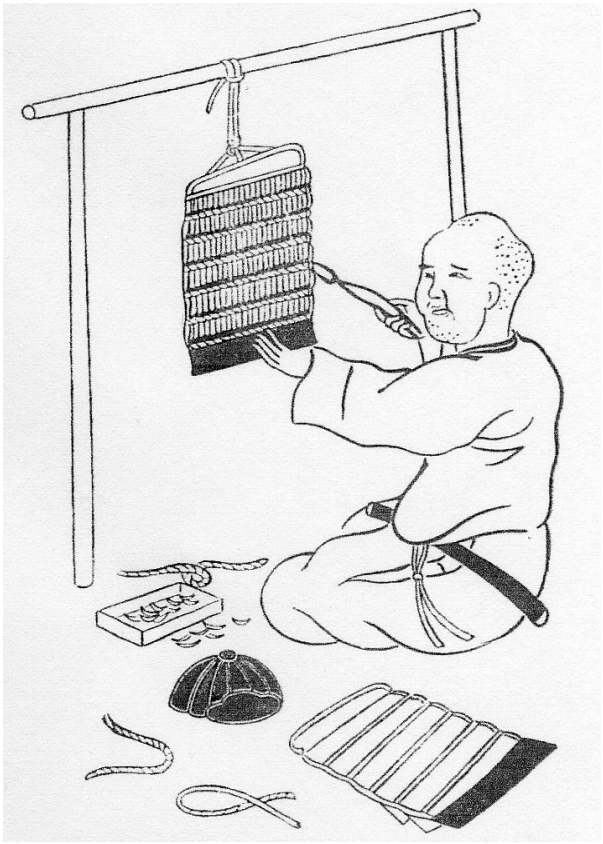

Fig. 5. 18th-century armorer making final adjustments to a *sode*. Kózan p. 30.

Fig. 6. A *do* with minimal lacings. The finest metal used for armor consisted of an outer layer of steel and an inner layer of iron, covered with *urushi* (lacquer).

How time takes its toll

Curators and collectors are familiar with issues such as deteriorated lacings, missing bindings, delaminating linings, and torn fabrics that occur routinely when organic and inorganic elements are at battle with each other. A good example of this is *kikkō*, the network of hexagonal plates sewn between layers of fabric or leather. *Kikkō* provides a thick layer of protection against arrows or sword points while their multi-faceted design allowed for movement in every direction. The many hard edges of the metal can eventually wear through the fragile layers of fabric, causing the *kikkō* to split open and reveal, the metal plates (fig. 7).

Fig. 7. This shoulder pad is made of *kikkō,* or hexagonal plates sewn between layers of fabric. The behavior of these different materials over time and under stress has caused the textiles to fail.

In some cases, an aspect of the manufacturing process will lead to conservation issues down the road. Take the problem of rust, for example. Kōzan felt that dog or horse leather was preferred because other types of leather contain salts, which can encourage the iron components in the armor to oxidize. Mail was always lacquered to prevent oxidation; however it is not uncommon to see rust on older mail. Lacquer can not adhere as well to the tiny moving parts of mail as it can to a large flat surface, so it often fails. Because mail is never worn alone, but instead stitched to a leather or textile substrate or even sandwiched between two layers of cloth, the textiles are also susceptible to burnout and tearing if rust becomes active (fig. 8). If the stitching holding together the various layers of materials disintegrate, an artifact can fall apart without damage to any of the main components, making repair easier for the conservator (fig. 9).

Dyes, especially dark saturated colors, can contribute to accelerated degradation of textiles. Carbon and iron were used to create black dye. Over time heavy metals and organics may cause microscopic chemical changes that are reflected by weak or shattered fabrics. A cotton textile printed with black dots in the design may deteriorate to the point that the black dots become small holes. These examples of chemical deterioration of dyes are exacerbated if the artifact is exposed to light or extreme fluctuations in temperature and relative humidity.

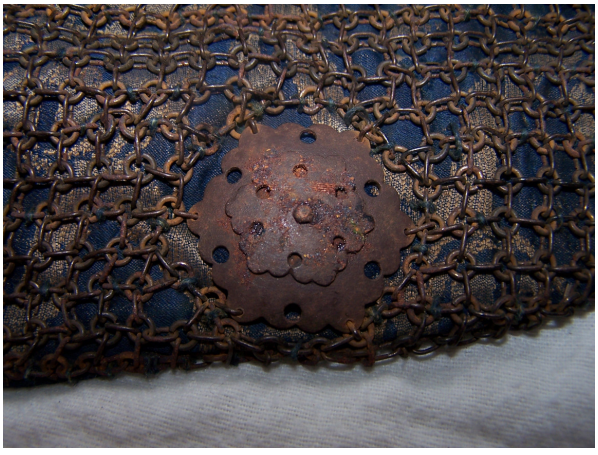

Fig. 8. This detail of mail on a *kote* clearly shows that the metal has started to rust. Fortunately it is not yet causing damage to the silk textile below. If this artifact is exposed to high RH and temperature fluctuations, the rust will worsen and begin to affect the neighboring materials.

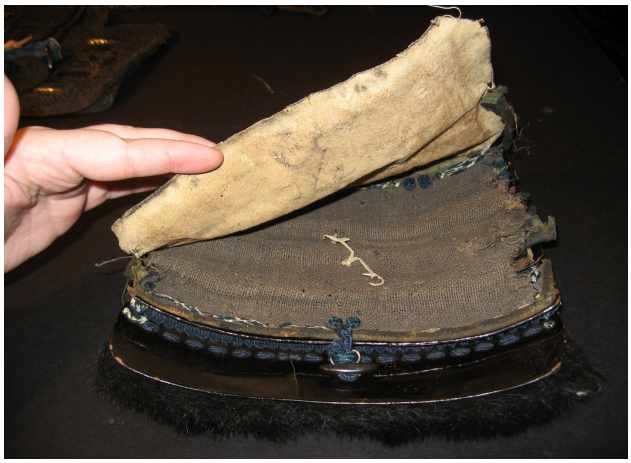

Fig. 9. Here we see the underside of a *sode.* Damage to the edge and failure of the stitching has allowed the leather protecting the underside to detach, exposing vulnerable textiles inside.

Insects are a major threat to historic textiles, especially those kept in storage. Different insects attack different types of textiles according to their chemical makeup. Plant fibers such as cotton and hemp are made of cellulose and have a basic pH. The most common household insects that infest plant fibers are silverfish. Animal fibers such as silk and wool are made of protein and are naturally acidic. They may be preyed upon by protein-eating insects such as carpet beetles and webbing clothes moths. Kózan makes mention of a worm-proofing treatment for the course hemp padding called *saimi* that consisted of saturating the fiber with a liquid made from a tree root (p. 86).

Tears and holes in the textile components of armor are a part of the artifact's history. Often they illustrate the way the armor was used and add authenticity and mystique to the garment. *Kote* are especially vulnerable to wear around the hand, where maximum flexibility was required (fig. 10). On a thigh-protector, or *haidate,* damage is often seen where the hard and soft materials meet and flex, and a hole where a weapon was rested on the thigh is not uncommon. Proper conservation, therefore, must stabilize the object without covering over or erasing this information.

Not all damage is as easily recognized as a hole or a tear. As silk *odoshi* lacings deteriorate they become susceptible to abrasion, leaving behind powder on hands, surfaces, and other fabrics. In addition to powdering, some signs that lacings have deteriorated include loss of definition in the braided surface and loose scales or other armor components that are held by the lacings. Sword wrappings were routinely changed, as often a once a year, so it is unlikely that the lacings found on most Samurai armor today are original. The texts I consulted stated that most lacings are faded from their original color, so a vivid, pristine lacing is almost certainly a restoration. That said, a historic restoration is still a vital part of an artifact and should receive the same level of care. Having lacings replaced by a professional restorer of Samurai armor is rarely an option due to cost, lack of proper materials, or lack of qualified personnel.

Fig. 10. The damage and loss on the inside of this *kote* is part of the artifact's history. Conservation must stabilize the area to prevent further damage without covering up this information.

Preventative conservation

Inadequate handling, display, and storage will exacerbate any condition issues present in samurai armor. These artifacts are particularly susceptible to inadvertent damage because the heavier metal elements rely on the textile elements to hold them together. The simple act of taking a *do* out of its *bitsu*, or storage box, can be harmful if the fragile condition of the armor is not taken into consideration.

Other than proper handling, environmental control may be the single most important element in preventative conservation. Collectors and museums alike need to take care to provide the appropriate temperature and relative humidity (RH) to protect the textile and metal elements of samurai armor against accelerated ageing and mildew bloom. The following guidelines should be observed:

- Stabilize temperature and RH
  Artifacts should not be stored in a location that is subject to sharp swings in temperature (such as an attic) or RH (like a basement) but instead should be kept in the parts of the building that are comfortable for people. Placement should avoid direct exposure to forced-air vents.

- Consider the artifact as a resident
  A temperature range of 55-75 degrees Fahrenheit, with a mild seasonal swing, is suitable for preserving historic collections. To maintain this range, proper air conditioning or heating is essential.

- Provide a comfortable RH level
  Air conditioning will not only control temperature but also dry out muggy summer air. A thermostatic air conditioner set at 75 degrees throughout the warmer months will maintain a comfortable environment for artifacts as well as people. To avoid extremely dry conditions in winter keep the temperature as low as you can. Cooler air holds more moisture than warm air and therefore will not dry out the building and its contents.

Light is essential for appreciating art, but it is also one of the most common causes of damage. Japanese lacquer is very strong, however light exposure will make it porous, more easily damaged, and cause the finish to dull. Whenever possible, artifacts should be kept in a place where the lights are turned off when not being viewed. If a separate storage or display area is not available, observe the following lighting guidelines:

- Avoid placing armor near a window
  Displaying an artifact near a window or beneath a skylight subjects it to the daily swing of sunlight, which brings with it a rise in temperature and causes objects to expand and contract. This constant fluctuation acts like a saw that weakens fragile fibers and separates lacquer layers. A far better solution is to have the armor in an interior location with a low-level of artificial light that is used only when in view.

- Do not display armor in strong light
  Whether displayed under artificial lighting (fluorescent, incandescent, halogen etc.) or viewed with natural light, the amount of light should be limited to as low a level as possible. 50 Lumens is the industry standard, but it is based simply on the least amount of light in which most people can still see details. Use your own judgment and be conservative.

- Keep light sources a safe distance from artifacts
  Make sure your light is not creating a harmful hot spot on the artifact. More diffused light will provide better viewing and protect the artifact.

Museum exhibition guidelines recommend that textiles be on display no more than six months out of any 12-month period. This is often achieved by rotating two or more objects in the same display area throughout the year. Some recommendations to observe are:

- Provide UV filtration
  If at all possible utilize a museum-quality display case capped with a UV-filtering acrylic bonnet. This will filter out most of the harmful UV portion of the visible light spectrum, and will also protect the artifact from dust and handling.

- Stabilize armor for display
  Display should be considered an option only for artifacts that are in stable condition. Damaged armor will only become more damaged from exposure, gravity, and handling. Locate a conservator to provide a condition report and recommendations for stabilization and display by visiting the American Institute for Conservation's website at http://aic.stanford.edu/public/select.html.

- Work with professionals
  A professional case builder will be able to make you a display unit that provides the safest possible environment for your artifacts. Either a case builder or a conservator will also construct an archival display support that both protects your armor and shows it off at its best. Although wood forms are traditionally used for display, they are not good for the textiles and not particularly supportive.

Owners and collectors are the first line of defense in the preservation of armor. Continued study and appreciation of an artifact necessitates proper care. Follow these guidelines to when maintaining and preserving a collection:

- Provide proper storage
  Traditionally armor has been stored in *bistu*, wooden box(es) constructed for armor storage. Each individual component was wrapped to protect it from damage. (Fig. 11) Washed cotton fabric such as sheeting or muslin is a good choice for wrapping your armor, as is unbuffered acid-free tissue. If your lacings are powdering, opt for tissue rather than fabric, as fabric has more tooth. Always place the stronger or heavier items into the *bitsu* first and lighter or more fragile items on top.

- Use high-quality storage materials
  Bitsu are commonly used as the base for armor display. For storage it is wise to invest in an archival box from a conservation supply company such as Hollinger Corp. (http://www.genealogicalstorageproducts.com/inpolcorbox.html). The best material in which to store armor is inert corrugated polypropylene, such as coroplast. It is stronger than acid-free cardboard, will never reacidify, can be easily cleaned, and is resistant to pests. Depending on the number of pieces in your collection, you may want to buy two or more smaller boxes rather than one large box. Line each box with cotton fabric before placing the individually wrapped items inside. Use plenty of crumpled unbuffered acid-free tissue for support.

Fig 11. Illustration of *Bitsu* or *Karabitsu* from an early 19th-century copy of *Yoroi Chakuyo Shidai*.

- Avoid unnecessary handling
  Label the outside of the box to avoid unnecessary handling. Identify the contents by taping an archival plastic sleeve to the box and inserting paper records and photographs into the sleeve. If boxes will be stacked, place the label or sleeve on the side of the box rather than the top. Number both the tops and bottoms of the boxes with a number so that they are not mixed up.

- Remove dust and loose dirt
  If you have experience handling artifacts, you may be able to lightly clean your armor yourself. Wash your hands or wear plastic gloves (cotton gloves will pull fiber from weakened textiles). Place the artifact on a clean surface covered with white paper. Using a soft natural-fiber paint brush, gently brush off the armor starting at one end and moving to the other end. Brush particles onto the paper and then discard the paper. Be extremely careful with fragile textiles or rusty metal. Cleaning is only recommended before the armor is places in storage, after it comes off open display, or as needed after several years. Armor can also be vacuumed with a low-suction collections vacuum and a micro-suction attachment, if these supplies are available and you have been trained by a professional.

- Temporary stabilization
  If your armor has condition issues such as torn fabric, loose elements and separating layers, you can temporarily stabilize it for storage or until a conservator can assess it. An inexpensive way to do this is with nylon net (also known as bridal tulle) available at a fabric store. Net comes in many colors and more than one quality. Choose a neutral tone in the softest grade you can find—darker colors will blend better than light colors. Cut the net to the size you require and wrap it around the damaged armor two or three times, as you would bandage an arm. Secure the end by tucking it into the wrapping, or stitch it to itself if you know how to sew. The net is see-through, inert, and can be left in place as long as necessary.

Conclusion
Samurai armor is unique in the exquisite way that its disparate elements work in harmony. Combining strength and elegance, it is a silent witness to the brave and skilled warriors who wore it and to the exquisite craftsmanship and industry that created it. As caretakers of these historical artifacts, it is our duty and honor to ensure their ongoing preservation and appreciation.

References
Bottomley, I. and A. P. Hopson. 1988. *Arms and Armor of the Samurai: The History of Weaponry in Ancient Japan*. Connecticut: Crescent Books.

Kōzan, S. 1963. *The Manufacture of Armour and Helmets in 16th Century Japan (Chūkokatchū Seisakuben).* Trans. T. Wakameda. Vermont: Tuttle.

Spectacular Helmets of Japan 16th-19th c. 1985. Exhibition catalog. New York: Japan Society.

Guidelines for the Care of Textiles developed by the Textile Museum, Washington, DC. http://textilemuseum.org/care/brochures/guidelines.htm

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