Recent Advances in Barkcloth Conservation and Technical Analysis

Proceedings from the symposium held at Royal Botanic Gardens, Kew on 7 December 2018

Edited by Misa Tamura, Charlotte Ridley and Frances Lennard

Exploring Support Materials and Adhesives for the Repair of Barkcloth: Aspects of Conserving Tapa Elements of a Tahitian Chief Mourner's Costume

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Introduction

The British Museum holds one of the most complete examples of a Tahitian Chief Mourner's costume, or *heva tupapa'u* (Figure 1). This extraordinary and elaborate costume would have been worn by a high ranking official in Tahitian society as part of a dramatic mourning ceremony marking the death of a Tahitian chief. Its imposing presence aimed to instil fear and awe in the community, who the costumed Chief Mourner would terrorise along with a troupe of assistants as part of a demonstration of grief (Henry 1928). One of only six complete costumes in museum collections across the world, the British Museum's *heva tupapa'u* is believed to have been collected by Captain Cook in 1773 on his second voyage to Tahiti. It is an invaluable example of Tahitian cultural history and of a ceremony now no longer in use or fully understood.

Figure1. The Tahitian Chief Mourner's costume, *heva tupapa'u* (pictured after conservation) with details of the barkcloth elements discussed. © Trustees of the British Museum.

Extensive research and conservation of the costume were undertaken in preparation for the British Museum's exhibition *Reimagining Captain Cook: Pacific Perspectives.*[1] This work involved collaborations between conservators, curators and scientists, both at the British Museum and further afield, including visiting Tahitian colleagues. The costume itself is comprised of some of the most valuable materials in Tahitian culture at the time, including barkcloth, coconut shell, pearl shell and feathers, all processed with an astounding level of skill. Although many of these materials required conservation to enable display, this article focuses only on the treatment of two of the barkcloth elements of the costume: a thick, weighty, multi-layered barkcloth headcape (*ta'aupo'u)*; and an extremely finely beaten and fragile waist sash (Figure 1). Both these components needed to be secured to withstand the necessary strains arising from mounting the costume for display and long-term mounted storage but, due to the differing qualities of the barkcloths, the approaches to treatment were quite different.

Conserving the headcape (*ta'aupo'u)*

The headcape is a rectangular panel constructed from overlapping strips of coloured barkcloth made from paper mulberry (*Broussonetia papyrifera*) (Tamburini et al. 2019a). These strips are adhered together to create a red, black, yellow and natural (uncoloured) horizontal stripe design, with additional black triangular motifs applied to some bands (Figure 2).[2] The headcape was worn over a basketry cap, and was gathered and secured to the top of the cap by a separate barkcloth binding. Taking account of contemporary depictions[3] as well as the practicalities of wearing such a costume, discussions with curators and Tahitian colleagues concluded that the headcape as observed prior to conservation was incorrectly mounted and we agreed it was important to rectify this. Rather than falling down the wearer's back and upper body, it had been placed on the head effectively backwards, completely covering the face, and preventing the wearer from seeing out. Erroneously placed coiled rope elements (found positioned around the neck, rather than on top of the head) gathered the headcape in at the neck and, over time, the barkcloth had stiffened into this incorrect shape (Figure 2). The strips of barkcloth were separating in places where the original adhesive had failed and were actively at risk of further detaching with the pull of gravity and during movement (Figure 3).

[1] The British Museum exhibition *Reimagining Captain Cook: Pacific Perspectives* ran from the 28th November 2018 - 4th August 2019. It explored Pacific perspectives on the Cook voyages and displayed the work of contemporary Pacific artists, alongside objects collected on the voyages themselves.

[2] Analytical work carried out by Tamburni, Cartwright and Adams (2019b) has confirmed that the red colour is rubbed into the surface and is red ochre; the black colour is produced by carbon and the yellow is derived from turmeric.

[3] *Dress of a Chief Mourner at Otaheite* [watercolour on paper, artist not known], British Museum, London (registration number 1982,U.1602); *Otaheite: Dancing girl and Chief mourner. Drawings illustrative of Captain Cook's first voyage, 1768 -1770, chiefly relating to Otaheite and New Zealand, by A. Buchan, John F. Miller, and others* [watercolour on paper by Tupaia, 1769]. British Library, London; *A Toupapow with a corpse on it Attended by the Chief Mourner in his Habit of Ceremony* [engraving and etching by W. Hodges, 1778], National Maritime Museum, Greenwich, London.

The adhesion of these elements was necessary prior to humidification and reshaping treatments in order to maintain the alignment and structural integrity of the panel.

Figure 2. Headcape, *ta'aupo'u*, before treatment. Left: front view with headcoils. Right: back view without headcoils. © Trustees of the British Museum.

Exploring adhesives

At the British Museum there has been a preference for using a sodium alginate and arrowroot starch paste in the treatment of barkcloth and other plant fibre objects due to its good tack, flexibility, strength and reversibility (Wills 1995a; Wills 1995b; Peacock 1995). While there have been some concerns surrounding the long-term ageing of sodium alginate, such as yellowing and loss of flexibility (Poulpiquet 2012), review of past treatments with the adhesive at the museum over the past 30 years suggests it has continued to perform well in real time

(Pullan 2015).[4] However, the treatment of the Mourner's costume was an opportunity to explore alternatives and broaden adhesive options. This decision was further encouraged because of the probable use of arrowroot starch as the original adhesive joining the barkcloth strips of the headcape together.[5] Although newly added arrowroot starch would normally be applied in conjunction with paper repair material, not using arrowroot would aid future distinction between starches used in manufacture and those added during conservation treatment, which curatorial and collaborative partners felt was important.[6]

Figure 3. Separating layers of the headcape. © Trustees of the British Museum.

It was anticipated that the cape would need to undergo multiple humidification treatments, firstly in order to flatten the cape to re-align the separated layers, and then to re-shape it into a draped 'as-worn' form (Figure 4). The conservation adhesive would therefore need to maintain the join between the barkcloth strips in successive humidified states, be flexible

[4] Personal communication: conversations with Barbara Wills and Monique Pullan, The British Museum, March 2018 to November 2019.

[5] Personal communication with curator and former director of Te Fare Manaha (Museum of Tahiti and the Islands). Working with the conservation team for two weeks discussing materials, conservation approaches, and mounting decisions, she commented that the adhesive traces exposed on detaching sections of the headcape were most likely to be arrowroot starch, applied by rubbing secretions from a cut tuber during the original manufacture of the garment. It was felt important to be able to distinguish between the original adhesive, and conservation intervention, hence the approach taken.

[6] Although it is not currently possible to distinguish between the specific plant origins of starches analytically, it may be possible in future.

enough to allow manipulation during re-shaping and still be strong enough to hold the weight of the relatively heavy barkcloth during proposed long term mounting on a mannequin.

Figure 4. The image shows multiple cycles of humidification using Goretex to flatten and re-align layers, as well as the cape upright during later humidification into an “as-worn” shape. Neodymium magnets and acid-free card were used as “clamps” to apply pressure and hold laminated sections of the cape in alignment during upright drying. © Trustees of the British Museum.

Tests were carried out to assess the properties of various adhesives and adhesive combinations found in the barkcloth conservation literature (Table 1; Feller and Wit 1990; Norton 1992; Hill 2001; Johnson 2001; Austin-Dennehy et al. 2013; Poulpiquet 2012; 2015; Pullan 2015). Each adhesive was used to join two overlapping strips of barkcloth, selected from the museum’s handling collection and felt to closely resemble the weight and texture of the headcape. The adhesive was brushed onto both sides of a 12gsm Tengujo Japanese tissue paper carrier, placed between the two pieces of barkcloth, and dried under weights.

The samples were assessed in terms of ease of application, strength, flexibility and performance during and after humidification (Table 1). Accelerated ageing of samples was not within the scope of this project. Instead, assessments of likely changes to the adhesives in the long-term were made using previous studies in the literature (Feller and Wit 1990; Hakari, 1995; Hill 2001; Johnson 2001; Poulpiquet 2012; 2015; Pullan 2015).

Initial observations indicated that all the pure starches (wheat, arrowroot and tapioca) performed less well than the modified celluloses (Klucel G and methyl cellulose) and the acrylic Lascaux 498HV, and that adhesive mixtures performed best overall (Table 1). For example, wheat starch, well known for its suitability with cellulosic papers and plant materials (Feller and Wilt 1990; Norton 1992) was easy to apply, but lost too much adherence during humidification to hold the barkcloth strips together when manipulated. Importantly it also lacked flexibility in comparison to the modified cellulose ethers and acrylic adhesive. Similar properties were observed for the arrowroot and tapioca pastes, with the tapioca paste having the additional disadvantage of being difficult to brush out evenly.

However, the tests suggested the wheat starch paste provided a good base to which various other adhesives could be added to impart further desirable qualities, such as increased flexibility or resistance to moisture. A 50:50 mixture of a 10% wheat starch paste with Lascaux 498HV significantly improved flexibility and strength in comparison to wheat starch paste alone and maintained a strong join between barkcloth layers throughout the testing. While not as easy to reverse as the pure modified celluloses or pure starch pastes, the join could be reversed using small amounts of water and mechanical methods (also noted by Poulpiquet 2015). Use of similar acrylic adhesive and starch paste mixes have been employed elsewhere, for example to achieve improved bonding of paper repair patches to a black painted Cook Islands barkcloth (Pullan 2015), and on oiled Hawaiian tapa (Austin-Dennehy et al. 2013; Poulpiquet 2015). Because of its flexibility and strength during and after humidification, this adhesive mixture was felt to be most suitable for use in the re-lamination of the headcape.

Adhesive	**Ease of Application*[1]**	**Flexibility*[2]**	**Strength When Pulled*[3]**	**Strength When Peeled*[4]**	**Ability to withstand humidification*[5]**
Wheat Starch (10% w/v in water)	Good	Fair	Fair	Poor	Poor
Arrowroot (10% w/v in water)	Good	Fair	Failed	Fair	Poor
Arrowroot and Sodium Alginate (10% w/v in water)	Good	Very good	Good	Poor	Fair
Tapioca (10% w/v in water)	Poor	Fair	Poor	Poor	Poor

Klucel G (10% w/v in water)	Good	Good	Good	Good	Good
Methocel A4M (10% w/v in water)	Good	Good	Good	Good	Good
Lascaux 498HV	Good	Very good	Good	Poor	Fair
Wheat Starch and Methocel A4M (10% w/v in water) 1:1 ratio	Good	Very good	Good	Good	Good
Wheat starch (10% w/v in water) and Lascaux 498HV 1:1	Good	Very good	Very good	Good	Very good

Table 1: Empirical observations of adhesive qualities of mock-ups.

*[1] "Ease of Application" was observed as the perceived ease of application to tissue carrier using brush. *[2] "Flexibility" was based on informal feel of samples when bent and manipulated. *[3] "Strength when pulled" was tested by pulling edges of samples upwards and downwards in opposite directions and noting resistance. *[4] "Strength when peeled" was based on resistance to the two pieces of barkcloth being peeled away from each other using fingers. *[5] "Ability to withstand humidification" was based on the perceivable ability of the barkcloth to remain adhered during manipulation after humidification for four hours using Goretex and a damp cotton layer.

Securing separated barkcloth layers

Rather than applying the adhesive directly onto the barkcloth, it was first applied to a tissue carrier. Using paper to hold the adhesive instead of direct application onto a substrate controls the quantity of adhesive used, reduces the risk of staining, enables the identification of conservation treatments, and eases future removal of repairs. A 12gsm *tengujo* tissue paper was water torn into circles approximately 3cm in diameter and pasted with the Lascaux 498HV and wheat starch adhesive mixture, effectively creating a conservation 'glue dot'. These 'glue dots' were placed at strategic intervals along areas of delamination whilst the adhesive was still moist. Long 'spatulas' of Melinex® (polyester film) helped to position the glue dots, as the separation between the strips of barkcloth was often partial and access difficult (Figure 5). After insertion, the barkcloth was weighted with glass weights until the adhesive dried. When applied where the headcape was in a three-dimensional form, magnets were used to apply pressure and hold the joins in alignment during drying. The repairs successfully secured the layers of the headcape, allowing it to undergo humidification and manipulation during successive re-shaping treatments, and ultimately to be mounted in its new "as-worn" orientation.

Figure 5. Inserting Japanese tissue 'glue dots' using a Melinex® spatula. © Trustees of the British Museum.

Conserving the barkcloth sash

Because of the fineness of the barkcloth used in the sash its conservation requirements differed significantly from that of the headcape, though it too required substantial work to enable safe handling and mounting. Tied around the waist and hanging down either side of the body to floor length, the sash is made from large sheets of very high quality barkcloth constructed in three thinly beaten layers, lightly adhered together.[7] Fine parallel lines created by incised beaters form a distinct pattern, where the regularity and precision of alignment denotes the skill of manufacture and quality of the cloth.The sash is a rare feature of the British Museum's costume, with only one other example believed to be associated with a Mourner's costume in the collection of the Museo di Storia Naturale, Florence, Italy.[8] A replica sash based on the British Museum example supplements the display of an incomplete costume at Perth Museum.

[7] Made from paper mulberry (*Broussonetia papyrifera*) (Tamburini et al. 2019a)

[8] Personal communication via email with M.G. Roselli, curator at the Museo di Storia Naturale, Florence, Italy, 8 October 2018. Discussions suggested that their example also has a barkcloth sash component, though further confirmation is required.

Although most of the sash was in remarkably good condition, the barkcloth was torn and severely fragmented on the inner surface of one side. The damage, possibly caused by nesting rodents or repeated abrasion, resulted in the thin layers of barkcloth delaminating and the torn barkcloth becoming crushed and crumpled. It was unclear how much loss had been sustained and there was real risk of further loss during handling and movement (Figure 6). Highly unusual small animal motifs, hand painted in red colourant[9] were discovered hidden within the drapes of the sash. Their proximity to the damaged area and the likelihood of interest in viewing these designs meant that it was particularly important to secure the damage and ensure this section of the sash could be both displayed and safely handled by researchers.

Figure 6. Damage and delamination of the fine barkcloth layers on the inside surface of the sash. © Trustees of the British Museum.

Exploring facing materials

The torn and crumpled sections of barkcloth could be relaxed and realigned using an ultrasonic humidifier. A method was then required to secure down the damaged and fragile sections. In some areas it was possible to secure the barkcloth by inserting adhesive between layers, similar to the 'glue dot' method described above. However, in most cases this did not secure vulnerable edges, nor was it appropriate for more fragile sections. Instead, the use of

[9] Most likely *noni (Morinda citrifolia)* (Tamburini et al. 2019a; Tamburini, Cartwright and Adams 2019b).

a semi-transparent facing to secure and protect the fragmented and delaminating barkcloth was explored. Tests were carried out using a range of potential facing materials including nanocellulose/bacterial cellulose (BC) paper, silk crepeline and thin Japanese tissue papers, applied to samples of comparable barkcloth taken from the museum's handling collection. These were assessed for visual discreetness when placed over a large area of barkcloth, how well they adhered to the barkcloth with various adhesives, and whether the faced barkcloth remained lightweight and flexible.

Nanocellulose paper, or bacterial cellulose (BC) tissue, is one of the newer papers to be employed in conservation and its uses are still being explored (Völkel et al. 2017). A benefit of the material is that the special microcrystalline structure of the nanocellulose fibres makes it a very high strength material relative to its thinness (Völkel et al. 2017) with good wet strength properties. The BC tissue was easy to colour with acrylic and watercolour paints. It did not tear on handling when wet and adhered well to the barkcloth with various adhesives. Interestingly, initial tests indicated that it appeared to also adhere to the barkcloth with water alone (without adhesive), possibly due to the thousands of microfibrils increasing hydrogen bonding.[10] How well this adhesive-free join would perform in the long term, and with manipulation, would need further investigation. However, the BC tissue was more opaque than the other materials and somewhat masked beater pattern detail.

Drawing on textile conservation techniques, silk crepeline was also considered. When applied as a facing using modified celluloses or starch pastes alone, the crepeline was found not to be strong enough without additional stitching to secure patch edges, a common textile conservation practice, though not possible with barkcloth. Lascaux 498HV was found to be strong and flexible in combination with the crepeline. However, there were concerns that it would retain a slight tackiness upon drying; wet application of the adhesive on the crepeline would cause staining and dry application would necessitate the use of heat or solvents, which the sash was too delicate to withstand. Ultimately, an ultra-fine 3.5gsm *tengujo* paper was found to be most suitable. The particularly thin nature of the paper enabled the beater pattern to remain visible after facing, but the long fibres of the paper made it strong enough to protect the fragments' vulnerable edges. The thinness of the paper did make it difficult to colour using water-based paints, but it was available commercially dyed in a variety of suitable colours.

Applying the facing

The adhesive used to secure the facing required a high degree of flexibility to retain the textile-like drape of the sash, as well as a good level of peel strength to withstand repeated handling during mounting and future research. Because of the fineness of the facing paper, the adhesive also had to have no, or very little, shine when dry. Drawing on the results of the adhesive tests carried out to treat the headcape, a 50:50 mixture of 5% wheat starch paste and 5% methyl cellulose (Methocel A4M) was found to meet these criteria and was chosen for treatment. The addition of the methyl cellulose was felt to increase flexibility of the wheat starch paste, while the starch element of the mix helped produce a stronger bond than the methyl cellulose alone.

[10] Personal communication: email conversation with G. Ulbricht, maker of BC tissue, on September 12th 2018.

To apply the facing, two methods were taken forward: one wet and one dry. The wet application, based on paper conservation wet drop lining techniques, involved pasting adhesive onto a piece of tissue, pre-cut to the required size and shape, on a cedar wood board (Figure 7). The absorbency of the wood reduced the amount of moisture carried by the wet paper, making it easier to handle without tearing, and less likely to stain the barkcloth on application. Either tweezers or a bamboo stick could then be used to lift the wet paper off the wooden board, and lay it in place over the surface of the pre-humidified and realigned barkcloth, tamping it down with a bristle brush to ensure good contact. While this method produced a join with good contact and no shine after drying, handling larger wet tissue facings proved difficult due to the poor wet strength of the very fine tissue, and so the technique was only used to treat smaller areas.

Figure 7. Wet application of facing involving pasting the tissue on a cedar board. © Trustees of the British Museum.

A second 'dry' method using remoistenable tissue was found to be more manageable and quicker. This involved pasting the adhesive on to the tissue, and allowing it to dry. The dry adhesive-coated tissue was then cut to size and the adhesive re-activated using water once it was in place on the barkcloth. The benefit of this method was that larger facings could be cut from the dry tissue against a Melinex® tracing, and the need to manoeuvre wet tissue was eliminated. By pasting the tissue out onto a textured Tygaflor® Teflon mat, it was both easier to remove once dried and did not develop the significant shine found on adhesive coated tissues pasted onto smoother materials such as Melinex® or polythene.

Figure 8. Using an ultrasonic humidifier and stipple brush to secure facing in place. © Trustees of the British Museum.

Figure 9. Interior of the sash before treatment (left) and after treatment (right). © Trustees of the British Museum.

To secure the overlay in place, the area of barkcloth to be faced was humidified using an ultrasonic humidifier. This relaxed the fragile barkcloth and made it more flexible to work with, as well as encouraging reactivation from the adhesive coated side of the patch. By ensuring similar moisture content in both tissue facing and barkcloth substrate, the risk of uneven tension and cockling on drying was also reduced. The facing was positioned in place, and the adhesive reactivated with cold water vapour applied using the ultrasonic humidifier. The ultrasonic humidifier enabled precise control over the amount of water applied, ensuring a sufficient amount to reactivate the adhesive fully, without over-wetting which might lead to a poor bond and staining. The facing was then tamped with a damp stipple brush to encourage full contact between object and tissue (Figure 8).

Through a combination of both methods, the damaged interior of the sash was secured (Figure 9). The results were felt to be very successful, particularly in terms of the flexibility and translucency of the facing material. The characteristic beater patterns remain clearly visible, whilst the surface texture of the tissue blended seamlessly into the surrounding barkcloth.
Elsewhere on the sash, the technique was also used to secure and sandwich fire-damaged barkcloth, possibly linked to records of fire outbreaks and damage to collections on board Cook's ship during the second voyage. The translucency of the ultra-fine tissue meant that these elements could remain visible whilst fully supporting these areas of damage. Similarly, the technique also proved useful when securing fragile pandanus leaf matting (Figure 10, left) which had been used as lining on the barkcoth and coconut shell apron of the *heva tupapa'u* (only half visible in Figures 1 and 2). The pandanus matting was very fragile and the apron had to be lifted on and off the neck of a mannequin a number of times during mounting. Sandwiching the vulnerable elements in ultra-fine tissue secured and strengthened them so they could withstand the rigours of mounting, yet left the weave-structure clearly visible. (Figure 10).

Figure 10. Visually discreet ultra-fine tissue used to support vulnerable pandanus matting around the neckline of a barkcloth, matting and coconut shell apron, another element of the *heva tupapa'u* (left); it was also applied to support historic burn holes on the sash (right).

Conclusion

Work on the Chief Mourner's costume provided an opportunity to re-evaluate and explore new adhesives, materials and methods for treating barkcloth. The various types of barkcloth found in the costume, and their conservation and mounting needs, meant that different methods and materials had to be used. The thicker, more textured barkcloth of the headcape required a stronger adhesive that could hold the heavy laminated layers together during display and withstand repeated humidification cycles. A wheat starch and acrylic mix, delivered wet on a paper carrier and applied in localised spots provided the best solution. The delicate barkcloth of the sash required the application of a flexible and lightweight facing to secure a larger area of fragmentation, whilst maintaining the sash's drape and the visibility of beater patterns. The adhesive needed to be flexible and have a high peel strength to withstand anticipated handling of an area with particular curatorial interest. The application of remoistenable facings with ultra-fine *tengujo* tissue and wheat starch/methyl cellulose adhesive mix in particular was very successful. The technique went on to be used in the treatment of other elements of the Mourner's costume to secure other materials and elements of the heva tupapa'u.

In both cases wheat starch paste was used as a base to which different adhesives were added to achieve qualities not found in either adhesive alone. These adhesive combinations give the conservator the ability to 'fine tune' the properties of starch pastes to suit specific needs, and together with the variety of different application methods - ranging from remoistenable tissues and the 'glue dot' - and the increasing number of different repair papers, demonstrate the ever-growing number of options available to the conservator. It is hoped that this work may prove useful to others and encourage similar experimentation.

Acknowledgements

Thanks are due to many people for their assistance with this work including but not limited to: Julie Adams (Curator Oceania, The British Museum), Theano Guillaume-Jaillet (Visiting curator, former director of Te Fare Manaha ,Tahiti), Rebecca Snow and Megumi Mizumura (Paper Conservators, The British Museum), Caroline Cartwright (Senior Scientist, The British Museum), Diego Tamburini (Andrew W. Mellon Postdoctoral Research Fellow, The British Museum), Rachael Lee (Textile Conservation Display Specialist, V&A Museum), The Radcliffe Trust, Normanby Charitable Trust, Dr & Mrs Lucas and The Wellcome Trust.

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Suppliers

Bacterial Cellulose Paper (BC), 4g M2- Japanese Mitsumata and Kozo base with Bacterial Cellulose (Gluconacetobactercilinus) produced in Germany by Gangolf Ulbricht. Also known as “Nanocellulose paper”.
Purchased online from Hiromi Paper
https://store.hiromipaper.com

Klucel G. Hydroxypropyl cellulose. Mixed with water (or alcohol) to produce adhesive. Powder purchased online from Preservation Equipment Ltd (PEL) https://www.preservationequipment.com/

Lascaux 498HV Acrylic Adhesive. Thermoplastic copolymer butyl-methacrylate dispersions thickened with acrylic butyl-ester. Used as pre-prepared by manufacturer though can be thinned with water.
Purchased online from Kremer Pigmente
https://shop.kremerpigments.com/en/

Melinex®, Archival Polyester sheet. 100 Micron
Purchased online from Preservation Equipment Ltd (PEL)
https://www.preservationequipment.com/

Methocel A4M. Quickly dissolvable medium viscous methyl cellulose which can be mixed with water to produce an adhesive.
Purchased online from Kremer Pigmente
https://shop.kremerpigments.com/en/

Tapioca starch (Red Mill brand) Mixed with water and cooked on a low heat for 25 mins whilst stirring to produce adhesive.
Purchased from Alara Health Store, 58-60 Marchmont St London

Tengujo paper, 3.5g/m2 untrimmed edges (in colours NAJ and GA)-Kozo fibre tissue. Purchased online via Hidakawashi Co, Ltd.

www.hidakawashi.com

Tengujo paper, 12gsm
Purchased from Shepherds Bookbinders (Falkiner Fine Papers) 30 Gillingham St, Pimlico, London

Tygaflor®, Teflon coated fabric
Purchased from Fothergill Engineered Fabrics Ltd
www.fothergillgroup.com

Wheat starch paste. Purified wheat starch paste powder. Mixed with water and cooked on a low heat for 25 mins whilst stirring to produce adhesive.
Powder purchased online from Preservation Equipment Ltd (PEL)
https://www.preservationequipment.com/

Author biographies

Sophie Louise Rowe has been an Organic Artefact conservator at the British Museum since 2016. She specialises in the treatment of historic objects, with a particular focus on collections from Africa, Oceania and the Americas.

Nicole Rode has worked as an Organic Artefact Conservator at the British Museum since 2004. She specialises in the conservation of textiles and textile-related material.

Monique Pullan is a textile conservator by training and has worked at the British Museum since 1994 where she has specialised in archaeological and ethnographic textiles, though her interests also lie with barkcloth and basketry as well as skins and feathers.