

IVORY WINDOW ENSEMBLE OF SUNDARI CHOWK

Report of the Institute of Conservation (IoC), University of Applied Arts Vienna



Fig. 1: Overview of the ivory window facing the Durbar Square, 2017 Complex

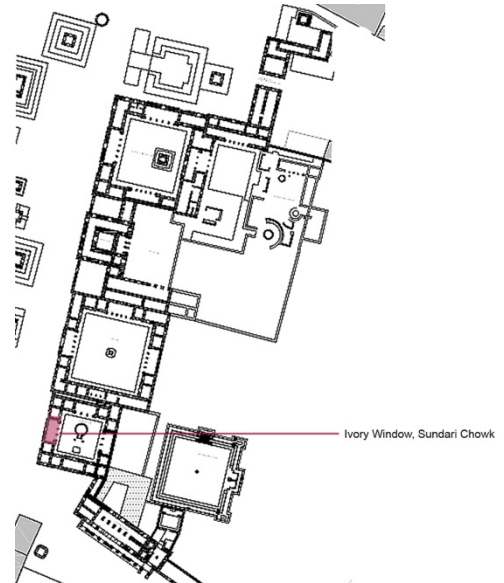


Fig. 2: Location within the Palace Complex

Data Sheet

Description

Since ivory is a hygroscopic material it is not suitable for exterior use. The high humidity and pollution in the Kathmandu Valley led to damage to the material, visible as cracks and deposits. Theft and the simple fall down of ivory carvings further contributed to a fragmented state of preservation.

Over a period of five years, the ensemble was thus treated by the Institute of Conservation.

The fragile ivory was consolidated and cleaned together with its wooden support. It was decided to exhibit the two ivory windows henceforth in the museum galleries inside the Royal Palace – to avoid their exposure to the weather and further loss. Instead, replicas will be placed on the façade. For this purpose, a suitable material to fabricate replacements for ivory had to be found. Different raw materials were tested and artificially aged under UV exposure in Vienna. Their appearance, workability and ageing behaviour under the environmental conditions in Nepal were examined. Test winner was an epoxy resin based mixture.

The copies were then created in close collaboration with local craftsmen. Today, they can be admired on the palace façade together with the re-installed conserved metal window.

Names	-	
Dated	1730	
Measurements (H x W x D)		
Materials/Technology	Ivory, wood (sal), metal, textile	Fire gilded repoussé copper
Interventions (IoC)	Survey	2013, 2017
	Mapping	2013, 2017
	Sampling	2013, 2017
	Analyses	2013, 2017
	Conservation	2013, 2017
	Maintenance	2017, 2022
Team (IoC)	Gabriela Krist, Manfred Trummer, Marija Milchin, Kathrin Schmidt, Lisa Gräber, Martina Griesser-Stermscheg	
Academic Research (IoC)	Pre-Thesis Regina Friedl	2013
	Thesis Marina Paric	2017

Survey: Materials and Technology

Window ensemble within the roof construction of the Sundari Chowk

Windows consists of an inner and outer frame.

Base of the window is supported by extended floor joints projecting out of the wall approx. 40 cm

Window construction consists of ten pieces in different shapes, held together by plug-in-systems

- Top of the window conically shaped with three rows of carved leafs;
- Leafs: One major form but six different styles of leafes; thinkness about 5 mm; fixed with iron nails on wooden support;
- Inner side of the arch with a house of deity;
- Inner frame is four-lined decorated with ivory;
- Gilded central window;
- Base of window is supported by wooden floor beam: 18 out of 22 are made out of pine;
- Sculptures carved in timber;



Fig. 3: Detail of fixing with nail within the wooden torana, 2013



Fig. 4: Detail after conservation with brass nails, 2017



Fig. 5: View from below - wooden structure and ivory top, 2017



Fig. 6: Detail of wooden support with some ivory parts fixed with brass nails, 2017



Fig. 7: Wooden reconstructed balustrade, 2017

Previous (Conservation) Intervention

Unknown Application of white coating on wooden support imitate missing ivory parts;
 Unknown/
 Before 1975 Application of white coating (zinc white) on ivory parts in order to “clean” them;

Survey: Condition and Causes of Decay (2013)

Thick layers of dust, formed to kind of poultrices;

Wood:

- Wooden beam showed wet-rot and pests;
- Missing and broken parts at small timber figures;
- Latticework was partly damaged and missing;

Ivory:

- 70-80% of ivory was missing;

Metal:

- 20% of metal elements were missing;
- Deformations;
- Cracks;



Fig. 8 and 9: Overview of the metal window, 2013



Fig. 10: Overview of an ivory window, 2013



Fig. 11: Detail of overpainted and brittle ivory, 2013 points, 2013



Fig. 12: Loose and missing parts, visible fixing



Fig. 13: Extremely dirty and damages ivory leaves, 2013



Fig. 14: Wooden Support after dry cleaning, 2013



Fig. 15: Deformed, broken and brittle ivory parts, 2013



Fig. 16: Wooden support with missing ivory parts, 2013

Conservation (IoC)

- Dismantling of the whole structure (while opening the roof top);
- Dismantling all wooden parts;
- Reconstruction of the ivory windows in 2017, in order to preserve the original ivory window within the Patan Museum;
- Maintenance work in 2022 in order to remove dust and soil (dry cleaning with different brushes);

Wood:

- Dry cleaning with brushes, rotating horse and goat hair brushes;
- Partial wet cleaning;
- Mechanical removal of white painting with scratching tools, scalpels, and glass fibre sticks;
- Uneasy removable white paint was retouched with gouache colors;
- Consolidation of fragile parts with Paraloid B72 in Acetone and Ethanol (1:1) using 10%;
- Fixing and gluing of broken parts with araldite;

Ivory:

- Removal of iron nails;
- Dry cleaning with soft brushes;
- Mechanical removal of white paint by glass fibre etc.;
- Cleaning of ivory with laser;
- Consolidation with 7% Paraloid B72 in ethyl acetate;
- Loose textile wrapping at the pillars were fixed with 5 % Klucel E in ethanol before applying the ivory parts;
- Fixing and gluing of broken parts with 30% paraloid B72 solved in ethyl acetate by temporary fixing with scotch tape (24 h);
- Reconstruction of missing parts in epoxy resin with marble powder, and acrylic resin;
- Fixing with brass nails;

Metal:

- Dry cleaning with soft brushes;
- Wet cleaning with water and detergent;
- Thick layers were removed with citric acid diluted in water;
- Rinsing with drinking water;
- Reforming of deformed parts by the local coppersmith with rubber- und skin hammers;



Fig. 17: Mechanical cleaning of ivory parts, 2013



Fig. 18: Front row of ivory leaves cleaned by laser, 2013



Fig. 19: Laser cleaning of the ivory parts, 2013



Fig. 20: Consolidation of ivory within the Museum, 2017



Fig. 21: Applied consolidant during drying, 2017



Fig. 22: Working at the reconstruction, 2017



Fig. 23: Working at the reconstruction, 2017



Fig. 24: Working at the reconstruction, 2017



Fig. 25: Mold with historical and replica ivory, 2017



Fig. 26: Carving replicas for the reconstruction, 2017



Fig. 27: View through the newly made leaves, 2017



Fig. 28: Reconstruction of missing casted deity, 2017

Conservation Materials used*:

Paraloid B72, araldite, titebond, scotch tape,

* All product / technical data sheets can be found at the additional file [A]

Before and after Conservation



Fig. 29: Overview of the Ivory Window ensemble from the Patan Durbar Square before conservation, 2013



Fig. 30: Overview of the Ivory Window ensemble with reconstructed windows from the Patan Durbar Square after conservation, 2017



Fig. 31: Overview of the preserved Ivory Window within the Patan Museum, 2022



Fig. 32: Overview of the preserved metal window without reconstructed parts before integrating in the ensemble, 2013

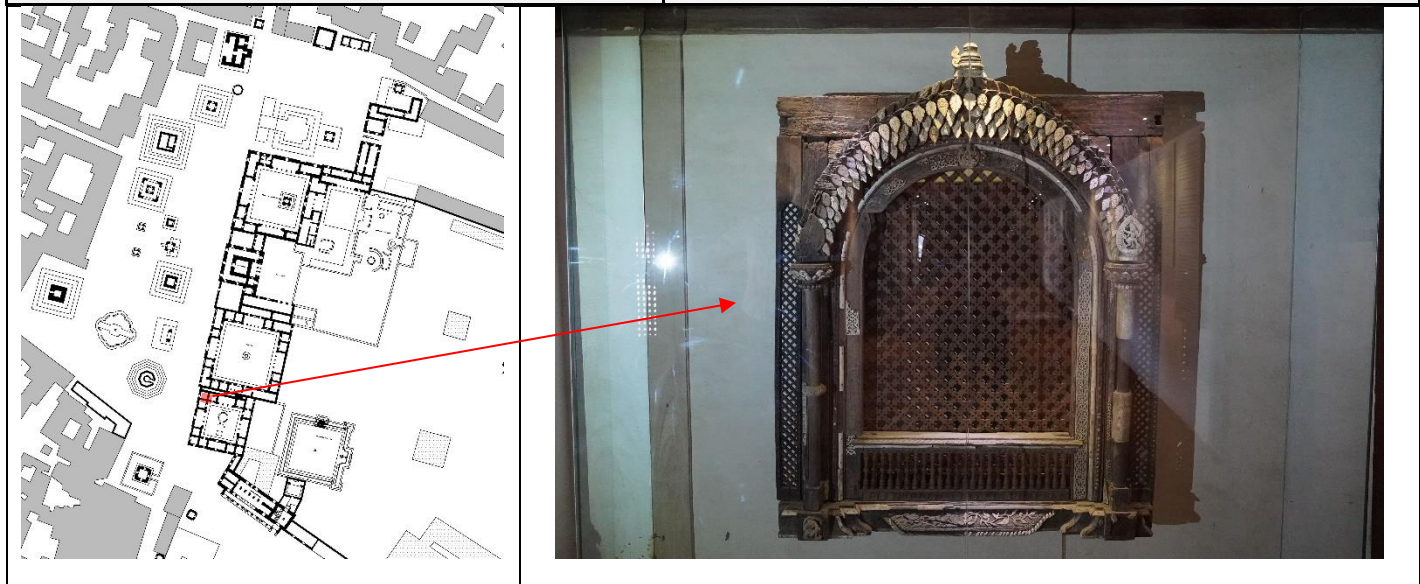
List of Publications / Reports (IoC)

Friedl, R., Looking through a window. The conservation and reconstruction of the Ivory Window of Sundari Chowk at the Patan Royal Palace – a Nepalese experience, unpublished Pre-Thesis, University of Applied Arts Vienna, Vienna 2013

Krist, G./ Friedl, R./ Trummer, M./ Bayerová, T./ Schmidt, K., Looking through a window: the conservation and reconstruction of an ivory window of Sundari Cok at the Patan Royal Palace, Nepal, in: IIC (Ed.), An Unbroken History: Conserving East Asian Works of Art and Heritage - 2014 IIC Congress, Hong Kong, 2014. Congress preprints, London 2014

Paric, M., The Ivory Windows of the Sundari Chowk at the Royal Palace in Patan, Nepal. Conservation and Reconstruction, unpublished Diploma-Thesis, University of Applied Arts Vienna, Vienna 2017

GENERAL INFORMATION		
Object / Monument Original ivory window / Sundari Chowk	Orientation	Size (H x L x W) -
Date of Production 18 th century	Location Exhibited inside Sundari Chowk	
Material and Technology <ul style="list-style-type: none"> - Wooden support structure - Carved ivory and wooden elements - Gilded copper plates - Iron nails - Brass nails (from conservation?) 		
Date of the last Treatment Conservation 2017: see Diploma of Marina Paric	Institutions of the last Treatment IoC	



EVALUATION	
Date of Evaluation May 2024	Evaluation done by Meral Hietz, Katharina Mendl, Fabian Sever
Recent Damages:	
<input type="checkbox"/> Stability Problems <input type="checkbox"/> Major <input type="checkbox"/> Medium <input type="checkbox"/> Minor	
Comment:	
<input type="checkbox"/> Broken / - into several Pieces <input type="checkbox"/> Many	

	<input type="checkbox"/> Some <input type="checkbox"/> Few	
Comment:		
<input type="checkbox"/> Loose / Missing Parts	<input type="checkbox"/> Many <input type="checkbox"/> Some <input type="checkbox"/> Few	- No new elements are likely to be missing
Comment:		
<input checked="" type="checkbox"/> Cracks / Holes	<input type="checkbox"/> Many <input type="checkbox"/> Some <input checked="" type="checkbox"/> Few	- Origin not traceable
Comment:		
<input checked="" type="checkbox"/> Deformation / Dents	<input type="checkbox"/> Major <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Minor	- Origin not traceable
Comment:		
<input checked="" type="checkbox"/> Abrasion / Worn out Gilding	<input checked="" type="checkbox"/> Major <input type="checkbox"/> Medium <input type="checkbox"/> Minor	- The gold layer is mostly worn out
Comment:		
<input checked="" type="checkbox"/> Corrosion	<input type="checkbox"/> Major <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Minor	- Slight green corrosion on the copper sheets - Slight corrosion of the iron nails
Comment:		
<input checked="" type="checkbox"/> Soiling	<input checked="" type="checkbox"/> Dust <input type="checkbox"/> Dirt	<input type="checkbox"/> Heavy <input checked="" type="checkbox"/> Medium <input type="checkbox"/> Light - Solid layer of dust on the entire surface (especially on the top sides) - Threads from cleaning on the whole surface - Some traces of active woodworm infestation have been detected
		<input type="checkbox"/> Heavy

		<input type="checkbox"/> Medium
		<input type="checkbox"/> Light
	<input type="checkbox"/> Blood	<input type="checkbox"/> Heavy
		<input type="checkbox"/> Medium
		<input type="checkbox"/> Light
Comment:		

Evaluation of the Condition

- good
- satisfactory
- unsatisfactory

Conclusion

The condition of the original ivory window, exhibited on the north-west upper floor of Sundari Chowk, was judged to be satisfactory. The two original ivory windows were replaced in 2017 by two reconstructions made with epoxy resin, and the remaining pieces of the original windows were joined together into a single window to be exhibited behind a glass panel.

The surface of the three windows is generally in good condition, but much dust has accumulated on the surface. There is some darkening of the gilded surface of the metal window, particularly in areas of worn gilding. Minor green corrosion has been noted. The reconstructed epoxy resin elements show varying degrees (condition 1-4) of ageing and yellowing, probably due to the use of different epoxy resins and varying amounts of fillers and pigments, but the overall appearance blends well with the surroundings.

Deposits (soiling, bird droppings) that accumulate on the surface over time are a major cause of corrosive reactions. In this respect, maintenance is the key to the long-term preservation of the Golden Window, but also of the epoxy reconstructed windows. Regular cleaning and removal of bird droppings must be considered by the local community as the most important factor in long-term conservation. Where citric acid is used to chemically reduce corrosion on the metal elements, it is essential that the surface is thoroughly rinsed after cleaning, as acidic residues accelerate corrosive reactions.

PHOTO DOCUMENTATION



Fig. 1: Original pieces of the ivory windows inside Sundari Chowk, May 2024



Fig. 2: Carved ivory and wood leaves and umbrella on the arch, May 2024



Fig. 3: Carved ivory and wooden leaves on the arch and missing deity at the top of the left column, May 2024



Fig. 4: Carved ivory and wooden leaves on the arch and deity at the top of the right column, May 2024



Fig. 5: Carvings in the lower part of the original window, May 2024



Fig. 6: Detail of the carved ivory leaves on the window arch, May 2024

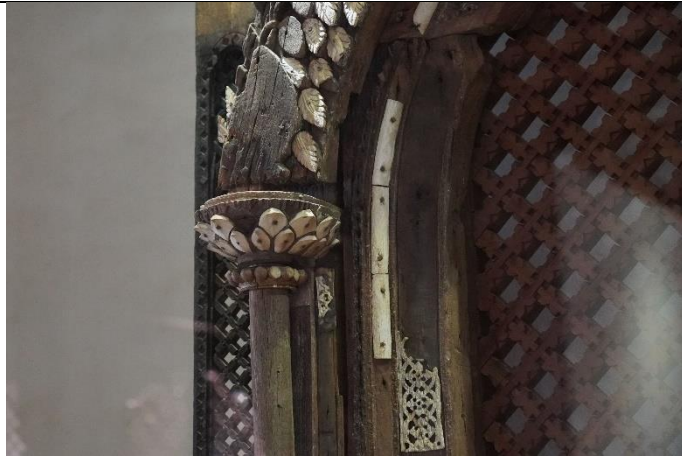


Fig. 7: Some missing elements on the left of the window, May 2024



Fig. 8: Som missing elements on the right of the window, May 2024

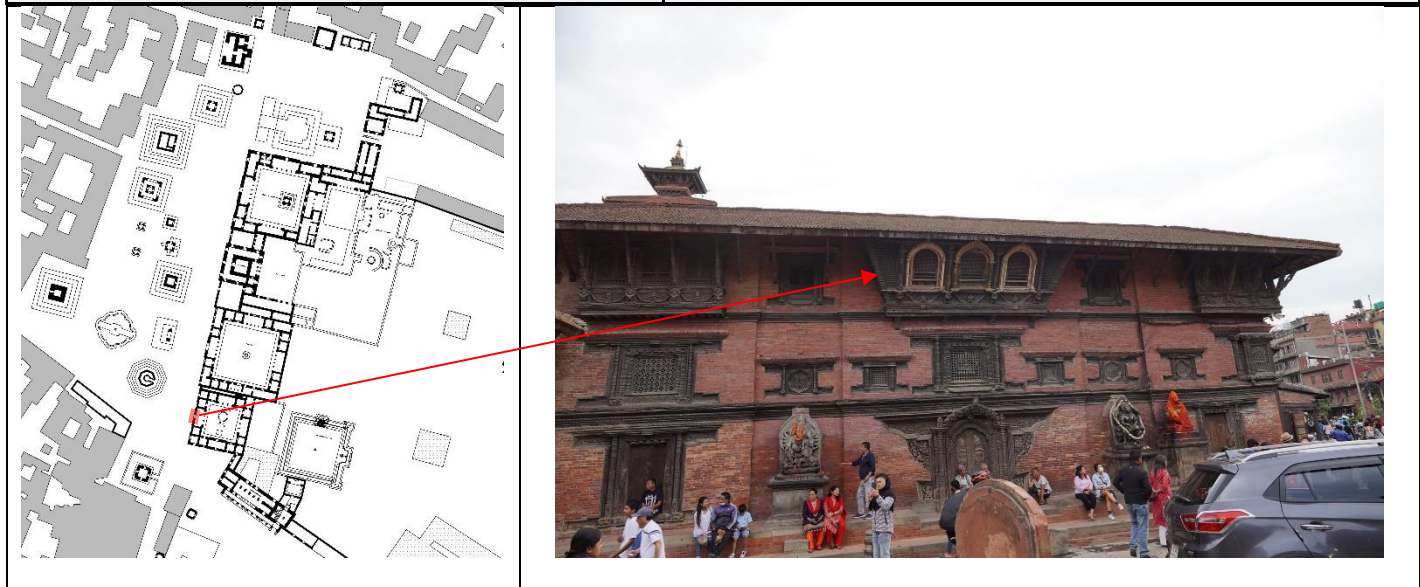


Fig. 9: Deity at the centre of the arch, May 2024



Fig. 10: Green corrosion on the copper sheets with almost all the gilding worn out, May 2024

GENERAL INFORMATION		
Object / Monument Golden window and two reconstructions of the original ivory windows / Sundari Chowk	Orientation Facing Krishna	Size (H x L x W) -
Date of Production 18 th century	Location Patan Durbar Square	
Material and Technology - Wooden support structure - Copper sheet repoussé - Iron nails - epoxy resin with pigments and fillers for the reconstruction of the ivory windows		
Date of the last Treatment Conservation 2017: see Diploma of Marina Paric	Institutions of the last Treatment IoC	



EVALUATION	
Date of Evaluation May 2024	Evaluation done by Meral Hietz, Katharina Mendl
Recent Damages:	
<input type="checkbox"/> Stability Problems	<input type="checkbox"/> Major <input type="checkbox"/> Medium <input type="checkbox"/> Minor
Comment:	

<input type="checkbox"/> Broken / - into several Pieces	<input type="checkbox"/> Many <input type="checkbox"/> Some <input type="checkbox"/> Few	
Comment:		
<input type="checkbox"/> Loose / Missing Parts	<input type="checkbox"/> Many <input type="checkbox"/> Some <input type="checkbox"/> Few	
Comment:		
<input checked="" type="checkbox"/> Cracks / Holes	<input type="checkbox"/> Many <input type="checkbox"/> Some <input checked="" type="checkbox"/> Few	<u>Metal window:</u> - One hole on the upper arc right side - 2 cracks on the lotus base - crack or hole on the left column - other cracks and holes not visible from afar
Comment:		
<input checked="" type="checkbox"/> Deformation / Dents	<input type="checkbox"/> Major <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Minor	
Comment:		
<input checked="" type="checkbox"/> Abrasion / Worn out Gilding	<input type="checkbox"/> Major <input checked="" type="checkbox"/> Medium <input type="checkbox"/> Minor	<u>Metal window:</u> - Generally worn out but esp. on the right pillar and mostly on the left pillar area below
Comment:		
<input checked="" type="checkbox"/> Corrosion	<input type="checkbox"/> Major <input type="checkbox"/> Medium <input checked="" type="checkbox"/> Minor	<u>Metal window:</u> - Darkening (s. Worn out gilding) - Few spots of green corrosion <u>Reconstructed ivory windows:</u> - Slight corrosion on the (iron) nails - Darkened surface of the copper nails - Yellowing of most of the epoxy resin elements Four stages of yellowing are visible:

1st stage (white or very slight yellowing): e.g. at the base zone of the right window and the putty on the pillar
 2nd stage (between light and medium yellowing): e.g. the deity on the left window in the centre of the arc, all three deities on the right window in the arc
 3rd stage (medium yellowing): most of the elements
 4th stage (extreme dark yellowing): some elements in the right window, e.g. the right pillar at the bottom and the left pillar in the middle

Comment:

Soiling

Dust

Heavy

Medium

Light

Metal and reconstructed ivory

windows:

- On whole surface especially top sides

Dirt

Heavy

Medium

Light

Blood

Heavy

Medium

Light

Comment:

Evaluation of the Condition

good

satisfactory

unsatisfactory

Conclusion

The condition of the golden window and the two reconstructed ivory windows on the facade of Sundari Chowk, facing west towards the Krishna temple, were judged to be satisfactory. The original ivory windows were replaced in 2017 by two reconstructions made with epoxy resin, which was adjusted to look like ivory by adding fillers and pigments, as part of Marina Paric's diploma.

The implemented technical measures on the metal window (e.g. reshaping of deformations, replication of missing parts, and replacement of loose elements) was carried out by local coppersmiths.

The surface of the three windows is generally in good condition, but much dust has accumulated on the surface. There is some darkening of the gilded surface of the metal window, particularly in areas of worn gilding. Minor green corrosion has been noted. The reconstructed epoxy resin elements show varying degrees (condition 1-4) of ageing and yellowing, probably due to the use of different epoxy resins and varying amounts of fillers and pigments, but the overall appearance blends well with the surroundings.

Deposits (soiling, bird droppings) that accumulate on the surface over time are a major cause of corrosive reactions. In this respect, maintenance is the key to the long-term preservation of the Golden Window, but also of the epoxy reconstructed windows. Regular cleaning and removal of bird droppings must be considered by the local community as the most important factor in long-term conservation. Where citric acid is used to chemically reduce corrosion on the metal elements, it is essential that the surface is thoroughly rinsed after cleaning, as acidic residues accelerate corrosive reactions.

PHOTO DOCUMENTATION



Fig. 1: Golden window and reconstructed ivory windows on the facade of Sundari Chowk, May 2024



Fig. 2: Close-up of the golden window and reconstructed ivory windows on the facade of Sundari Chowk, May 2024

[A] Product Data Sheets – Links¹ to Suppliers/Manufacturers

AEROSIL® 200

https://products.evonik.com/assets/or/ld/AEROSIL_200_TDS_DE_DE_TDS_PV_52043839_de_DE_WORLD.pdf

Aviva Silikat Grundierung

https://www.adler-lacke.com/Canto/tmb/aviva-silikat-grundierung_tmb_4079_de.pdf

Alkylbenzyltrimethylammonium chloride

<https://www.sigmaaldrich.com/AT/en/sds/mm/8.14858?userType=anonymous>

KluceI™ EF

<https://www.kremer-pigmente.com/elements/resources/products/files/63701-63713.pdf>

Aviva Tirokat-Color, Adler

https://www.adler-lacke.com/Canto/tmb/aviva-tirokat-color_tmb_4087_de.pdf

Mixtion Le Franc, Kremer

<https://shop.kremerpigments.com/elements/resources/products/files/98000e.pdf>

Waxes, Deffner und Johann

https://deffner-johann.de/media/datasheets/4186000/EN/Zusatzinformation_Wachse_DE_DJ.PDF

Injection mortar HFX

https://productdata.hilti.com/APQ_HC_RAW/ASSET_DOC_7567931.pdf

Köln Classic Ölmixtion 3h; 12h; 24h

<https://www.kolner-vergolderprodukte.de/produkte/koelner-oelmixtion/>

KSE 500 E

https://media.remmers.com/celum/export/documents/Remmers_0715_KSE-500-E-_Technisches-Merkblatt_de_DE_26355.pdf

Lascaux 498 20 X acrylic adhesive

[https://deffner-](https://deffner-johann.de/media/datasheets/2051100/DE/2051100_Technisches%20Datenblatt_Lascaux%20Acrylkleber%20498%2020%20X_DE_DJ.pdf)

[johann.de/media/datasheets/2051100/DE/2051100_Technisches%20Datenblatt_Lascaux%20Acrylkleber%20498%2020%20X_DE_DJ.pdf](https://deffner-johann.de/media/datasheets/2051100/DE/2051100_Technisches%20Datenblatt_Lascaux%20Acrylkleber%20498%2020%20X_DE_DJ.pdf)

Marble dust

https://www.kremer-pigmente.com/elements/resources/products/files/58500-58580_59001-59690.pdf

Natural hydraulic lime

<https://www.preservationworks.us/wp-content/uploads/2019/10/NHL-Datasheet-Lafarge-23.5.pdf>

Plextol B-500 (acrylic dispersion)

[https://deffner-](https://deffner-johann.de/media/datasheets/2556500/DE/2556500_Technical%20Data%20Sheet_Acrylic%20Dispersion%20B%20500_EN_DJ.pdf)

[johann.de/media/datasheets/2556500/DE/2556500_Technical%20Data%20Sheet_Acrylic%20Dispersion%20B%20500_EN_DJ.pdf](https://deffner-johann.de/media/datasheets/2556500/DE/2556500_Technical%20Data%20Sheet_Acrylic%20Dispersion%20B%20500_EN_DJ.pdf)

Primal® SF 016

[https://deffner-](https://deffner-johann.de/media/datasheets/2543001/DE/2543001_Technical_Data_Sheet_Primal_SF_016_DJ_EN.pdf)

[johann.de/media/datasheets/2543001/DE/2543001_Technical_Data_Sheet_Primal_SF_016_DJ_EN.pdf](https://deffner-johann.de/media/datasheets/2543001/DE/2543001_Technical_Data_Sheet_Primal_SF_016_DJ_EN.pdf)

AKEPOX® 2010

https://data.akemi.de/fileadmin/user_upload/products/productdocuments/TMB/Akepox_2010_TMB_D.pdf

¹ All links were last accessed on 13 May 2025.

EPO-TEK® 301-1

<https://www.epotek.com/docs/en/Datasheet/301-1.pdf>

Titebond Wood Glue

<http://sds.franklini.com/msds/1411.042k0nmo0020.pdf>

Paraloid™ B-72, Kremer

<https://www.kremer-pigmente.com/elements/resources/products/files/67400-67409.pdf>

Keim Granital®

https://www.keim.com/documents/de-AT/723/TM_Granital_DE-AT.pdf