ANJA BAYER

Abegg-Stiftung
Werner Abeggstrasse 67
3132 Riggisberg
atelier@abegg-stiftung.ch

DEPOSITS ON EXHIBITION GLASS DISCUSSED USING THE EXAMPLE OF THE PRESSURE MOUNT OF THE »LIBER LINTEUS« IN THE ARCHAEOLOGICAL MUSEUM OF ZAGREB

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The phenomena of white deposits on glass which is in direct contact with or a short distance from an historic, mainly textile, object has been described in literature since the 1970s. The introduction of this article is a short summary of the history of the linen bands of the Liber Linteus. A literature overview throws light on research done in the field of deposits on glass, concerning the observation and analysis of deposit components and the possible sources of these components. Furthermore, the articles discuss the mechanisms of deposition on glass and stimulating factors. Are there consequences for the historic object in the mount with deposits? Alternatives to silicate glass as glazing for exhibition mounts are discussed and a snapshot of ongoing research at the Abegg-Stiftung, related to this topic is given.

Keywords: Liber Linteus, deposits of fatty acids, exhibition glass, pressure mount

Ključne riječi: lanena knjiga, naslage masnih kiselina, nosač, staklo izložbenih vitrina

The *Liber Linteus* is a religious manuscript written in the second century BC – probably in Perugia (I) - on a linen panel at least 320 cm long. The fabric was folded in a certain way to form a sort of book. The existence of these kinds of writings is documented in written sources but the *Liber Linteus* is the only preserved example. It survived by being cut into strips and used as bandages for a Roman/Egypt mummy.

In the middle of the 19th century a European bought the Mummy and the bandages were taken off to study their inscription. In 1910 the fragments were restored and glued onto linen gauze. The glue was analysed as a mixture of starch and *gummi arabicum*.[1] At a later stage the bandage fragments were heat sealed in plastic foil. In this condition the fragments of the *Liber Linteus* arrived at the Abegg-Stiftung in 1985 for a conservation/restoration treatment. The aim was to prepare the *Liber Linteus* for an exhibition about the Etruscans in Perugia (I) the same year. Beside the conservation treatment technical analysis took place. The bandages were taken out of their plastic »tubes« and detached from the gauze. The order of the fragments within the original linen book was physically reconstructed and transferred into a pressure mount. The pressure mount consists of a cotton Molton and silk covered exhibition board; the fragments of bandages are arranged on a cotton fabric which reconstructs the outlines of the linen book. A glass sheet covers the board and is fixed by a metal frame which is screwed into the board on all four sides.

In retrospect the conservation treatment appears very successful. Even with modern methods the conservation would not proceed much differently. The major difference would concern the construction of the pressure mount. The Abegg-Stiftung's attitude has changed due to experience and now pays much more attention to layers of padding that may allow the object to sink in and be held in place by the glass cover instead of being pressed between rigid materials.

After the exhibition in Perugia closed in 1985 the *Liber Linteus* was brought back to Zagreb. During the war in Croatia from 1991 to 1995 it was stored in the cellar of the Archaeological Museums of Zagreb. Since then it has been exhibited in the museum with a short interruption of a loan to the Museum-Johanneum in Graz.

In 2008 the *Liber Linteus* got a new light installation and it was about this time that a greyish matter between the object and the exhibition glass was noticed but it was not possible to identify this without lifting the glass. As the object could not always be kept under ideal climate conditions, mould and deposits on the glass were both possible explanations for this phenomenon. It was reported, that during the autumn and winter season 2009/2010 the layer increased. The Abegg-Stiftung, Riggisberg (*CH*), was informed and asked for a consultation for the object which took place in February 2010. The glass sheet was lifted and white deposits on the glass could clearly be identified. The linen bands seemed not at all affected by the deposits.

The glass showed an overall, irregular cloudy haze. The linen bands were exactly depicted in this haze, showing its own pattern in even whiter and more transparent deposit areas. There are no deposits where the threads of the coarse weave structure of the linen fabric touched the glazing (compare to Fig. 1 and 2). Samples of the deposits where taken and the glass sheet was cleaned with water and a microfiber cloth. It was dried and polished with paper towels, put back on the exhibition board and the mount was closed again with its metal frame.

[1] The analysis was performed by Judith Hofenk de Graaf (ICN, Amsterdam) on behalf of the Abegg-Stiftung in 1985.

Research in this field in the past

The measure of cleaning the glass is simple and effective but unfortunately not permanent as a re-deposition can be noticed in a relatively short time, depending on a variety of facts. White deposits on exhibition glass are a disadvantage of using this as a material in pressure mounts.

In 1986 Nobuko Kajitani and Elena Phipps from the Metropolitan Museum of Art, New York, reported this phenomena on the occasion of the meeting of the Harpers Ferry Textile Group under the name »Water marks«. They related the problem to the almost immediate reaction of the material toward changes of temperature and linked this with changes of relative humidity inside the mount. However no analysis was undertaken of the composition of the deposits.

Already in 1978 an article from Margareta Nockert and Tommy Wadsten was published in *Studies in Conservation* describing deposits on glass sheets that covered card board boxes which contained the archaeological textile finds from Birka (Nockert – Wadsten 1978: 38-41). Agnes Geijer stored the finds in the 1930s in boxes as well as in frames of two glass sheets held together by adhesive plaster tape. They found amorphous and crystalline materials which IR-Spectroscopy proved to be the same substance, a sodium formate. Where the textiles were in direct contact with the glass sheet, the presence of heavy metals was detected too. Formic acid from the card board in reaction with the sodium from the glass was determined as a source for the deposits. The heavy metal compounds were only present in the residues if the textiles were in direct contact with the glass sheet and were therefore thought to derive from metal objects present in the tombs along with the textiles. Astonishingly enough no deposits are described from objects of the same find that were stored between two glass sheets.

In 1987 Tim Padfield and David Erhardt published research at the 8th Triennial meeting of ICOM (Padfield – Erhardt 1987: 909-913) about woven silk images that formed whitish copies on their glazing. They worked exemplarily on one of these objects. Without mentioning the method of analysis they stated that salts (sodium chloride) were present in the white film which could have derived from the silk object, the linen exhibition fabric and the cardboard backing. With several experiments they formed a theory for the emergence of the film. They understand it as being independent from the physical properties of glass but related it to the properties of salts in combination with organic materials and changes of relative humidity.

Susan V. Heald, Lucy Commoner and Mary Ballard published in 1994 the article »A Study of deposits on glass in direct contact with mounted textiles« (Heald – Commoner – Ballard 1993: 7-18). They carefully described different appearances according to the material stored under glass using a whole range of analysis methods to identify the substances. These were generally identified as saturated fatty acids and a decomposition product of unsaturated fatty acids. Migrated soaps present in exhibition fabrics and textile objects due to earlier processing and washing procedures were interpreted as the origin of these fatty acids.

Stefan Wülfert came to the same analytic conclusion, i. e. fatty acids and fatty acid salts, in a research undertaken for the Abegg-Stiftung in 1995.[2] With FTIR he analysed the deposits from the glazing of two pressure mounts in comparison with two samples of wash-

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2 Stefan Wülfert, Ablagerungen auf den Schutzgläsern montierter Textilien. *Untersuchungsprotokoll des Schweizerischen Instituts für Kunstwissenschaften* (SIK) vom 13.11.1995, Lab. Nr. 95/25.

ing agents used or formerly used in the conservation studio of the Abegg-Stiftung. Modern washing agents were excluded as a source for the deposits due to the differences in their FTIR spectra and the deposit samples. Wülfert stated that fatty acids and fatty acid soaps diffusion is noticed in non-textile objects like panel paintings too, but that these kinds of residues might have enhanced mobility due to the use of detergents in washing treatments but would not be rinsed off completely. As a major reason for the deposition on the glass sheets he mentioned the importance of the coefficient of thermal conduction of glass. Repetitive minimal heating/cooling cycles or the diffusion of water vapour, each caused by turning exhibition lighting on and off, climate control or the change of day and night would lead to the deposition phenomenon.

Anke Grit Weidner published her research in 2002 on four Peruvian textiles mounted in a glass/hardboard pressure mount with the typical white deposits on the glass sheets (Weidner 2002: 129-138). Using FTIR she found mainly salts of fatty acids in the deposits from two glass sheets with spectra comparable to Heald/Commoner/Ballard and Wülfert. For one object a mixture of sodium salt, sodium sulphate and sodium silicate was found (like Padfield/Erhardt even though their analysis method is unpublished) and on another glass a mixture of fatty acid salts and inorganic salts. She states that the composition of the deposits varies even on an individual glass sheet. She could exclude in this case study washing procedures as a catalyst for the deposits. Degradation products of the hardboard backing are named as a major source for the fatty acid salts. The textile objects themselves are a further origin and additionally a source for inorganic salts. The objects survived in various environments with salt migration such as burial settings. The deposition is explained by Weidner analogue to Wülfert with the presence of hygroscopic materials - glass as the nonhygroscopic »cold« material and changes of relative humidity due to temperature changes in the microclimate of a »pressure mount«.

The results of the deposits from »Liber Linteus«

The samples of the exhibition glazing from the *Liber Linteus* mount were analysed by Dr. Caroline Forster at the laboratory of art technology at the University of Applied Art Bern in April 2010.[3] The samples were taken from an area covered by the linen bands (sample 1) and where only the exhibition fabric was situated below the glass (sample 2). The analytical method used was FTIR analysis. Sample 1 consists of two substances, first a fatty acid salt comparable to sodium stearate and a silicate component, sample 2 shows absorption bands comparable to sodium palmitate.

Stearic acid and palmitic acid in compound with other saturated fatty acids like butyric acid, lauric acid and oleic acid are main components in products of animal and plant origin. Unsaturated fatty acids like linoleic or linolenic acid are additionally present in plant material products. The sources for the salts of these fatty acids are as wide spread as the natural material present in the pressure mount of the *Liber Linteus*, i. e. the linen bands, the cotton support fabric, the silk exhibition fabric and the wooden board below. The easiest explanation for the origin of the silicate substance is sand particles in the bandage as the mummy was presumably excavated from a desert area.

3 Job Nr. 100245AbS.

In the process of installing a new permanent exhibition at the Abegg-Stiftung several under-glass mounts with direct contact or a few millimetres distance to the textile objects were opened. The objects were examined and the glass sheets cleaned. Deposits from a variety of glass sheets covering objects of silk, linen and wool fibre, some printed or painted were analysed. Altogether 18 samples were analysed with FTIR at the University of Applied Arts Bern by Brigitte Lienert, laboratory assistant.

The results from the analysis of the deposits fit seamlessly in the spectra of analysis of deposits carried out in the past from the Abegg-Stiftung's objects and from the other researchers quoted above. Components found on the glazing are fatty acid salts, saturated fatty acids, an undefined Carbonate, calcium oxalte[4] and cellulose. Similar to the deposit analysis of the *Liber Linteus* glazing there is a difference noticeable between the deposits from an area with an historic textile object or with only the mount materials below. In all cases with only the mount materials underneath the glazing, the deposits consist of fatty acid salts. The deposits above historic objects may consist of fatty acid salts, but also contain the further components listed above. Saturated fatty acid was found in three cases, one from a silk with a fatty spot right below the sample area, and two from woollen areas of a wool/flax textile. The carbonate was found above a silk object, the cellulose above two flax fibre objects (a contamination of the sample by particles of the objects is very likely[5]) and the calcium oxalate above a silk object.

The results can be summarised by the statement that all components of a pressure or other under-glass mounts are participating with mobile components in the formation of deposits on silicate glazing. Components of the mounting materials are rather homogeneous and might be reduced to a certain extent by barrier or alternative materials. Components deriving from the museum objects are rather heterogeneous and can not simply be related to the object's material but are composed of soiling and often unknown additives – with the exception of the deposition of saturated fatty acids which in the research of the Abegg-Stiftung could be directly linked to a fatty substrate underneath the glass.

An interesting observation was made on the glass of a large object of partly painted linen from late antiquity. The glass needed to be lifted twice with the space of a month in between. The object was situated in a very stable climate controlled environment – and documented by a data logger, but without a double door system entrance to the outdoor climate. The storage is entered at least once a day for security control and once a week for cleaning by technical museum staff. Further actions are insect pest control and object consultations by conservators and curators. The turning on and off of unfocused room light has to be calculated with the opening of the storage entrance. Even though the influence of both these events does not appear on the climate data logger new white deposits were clearly visible on the glass after only one month. This observation underlines the fact that very low temperature changes catalyse the deposition process within the pressure mount. Presumably it is possible to measure these changes directly on the glass – but with what consequences? As soon as an object is supposed to appear on display minimal changes in environmental temperature will influence the temperature of the exhibition glass which is linked with changes of relative humidity within the under-glass mount. The start of migration of substances cannot be avoided.

[4] Salt of the oxalic acid. In nature an oxalate is a product of incomplete biodegradation of hydrocarbons and present in every plant material. In relation with calcium ions it forms a difficulty soluble molecule. From: http://de.wikipedia.org/wiki/Oxalate, 30.11.2011.

[5] Weidner (2002) reported that she found in her case study, textile fibres adhering to the glass while examining the deposits under microscope. Note 6, p. 130.

There are no comments published about a negative conservation influence of the deposition on the object underneath it or conservation problems due to the migration of substances through the historic textile object. Likewise at the Abegg-Stiftung, no negative or positive effects have been surveyed yet.

Alternatives to glass mounts

As stated above, the major reason for deposits on exhibition glazing is the choice of silicate glass. Kajitani, Phipps and Heald – Commoner – Ballard (1993:8) compared glass mounts with plexiglass® (PMMA-polymethylmethacrylate) mounts and on them no deposits could be detected. This result is not astonishing as PMMA has a much lower thermal conductivity than silicate glass, i.e. the mount with PMMA is less sensitive to temperature changes. Further advantages of plexiglass® glazing are the lower material weight, lowered risk of fracture and no spall fracture, UV-absorption and comparably better light transmission. Because of these advantages it is in widespread use and today more common for museum mount glazing than silicate glass.

The advantages of glass on the other hand are its higher chemical and physical stability compared to PMMA, which is, for example, essential for cleaning purposes in a public environment. It is available in bigger dimension and displays more stiffness, i.e. plexiglass® tends to bow at far smaller dimensions compared to glass. For this reason pressure mounts with PMMA need a different subconstruction to deal with this characteristic. Glass has a lower electrostatic charge which is especially essential in a pressure mount during the closing or opening procedure when light weighted textile fragments might adhere to the glazing. Antistatic agents are available but unwanted in direct contact with the textile object. Modern silicate glass is available in clear quality which allows better light transmission. The UV transmission can be avoided by an adequate choice of lightening media. The disadvantage of the necessity to open the mount for cleaning the glass glazing can be turned to the positive aspect of being able to closely examine the object at regular intervals e.g. 10 years, if an object is on display. On the other hand it is very likely that a mount with a PMMA glazing on open display needs replacement due to scratches from repeated cleaning action and possible interventions by the public.

Summary

White deposits on under-glass mounts for exhibition or storage purposes are a familiar phenomenon. They are restricted to mounts with silicate glass and are catalysed by very light temperature changes that cannot be prevented in an area with human access. The only preventive measure is to change the glazing to a less temperature sensitive material. A museum proven alternative is plexiglass® whereby advantages and disadvantages need to be carefully balanced. The influence of the migration of components forming deposits, as a conservation problem was not the object of research so far and seems to be negligible as the components do not differ whether they derive from the mounting materials or the object itself and no conservation problems have been reported to date.

Bibliography

Heald, S. C. – Commoner, L. – Ballard, M. W. 1993 – A Study of Deposits on Glass in Direct Contact with Mounted Textiles. *The Textile Specialty Group Postprints*. 3/1993: 7-18.

Nockert, M. – Wadsten, T. 1978 – Storage of archaeological textile finds in sealed boxes. *Studies in Conservation*, 23/1978: 38-41.

Padfield, T. – Erhardt, D. 1987 – The spontaneous transfer of an image of Joan of Arc. *ICOM preprints, 8th Triennial Meeting, International Council on Mueums*. Sydney (Australia), 1987: 909-913.

Weidner, A.G. 2002 – Montierung textiler Objekte unter Glas - Zur Problematik der Entstehung von Belägen an der Innenseite von Schutzgläsern. In: S. Martius – S. Russ (Hrsg.), *Historische Textilien - Beiträge zu ihrer Erhaltung und Erforschung*. Nürnberg, 2002: 129-138.

NASLAGE NA STAKLU IZLOŽBENIH VITRINA PROMATRANE NA TEMELJU PRIMJERA NOSAČA NA KOJEM JE IZLOŽENA LANENA KNJIGA (*LIBER LINTEUS*) U ARHEOLOŠKOM MUZEJU U ZAGREBU

Bijele naslage na nosačima zaštićenim staklom koji se upotrebljavaju prilikom izlaganja ili pohranjivanja umjetnina poznata su pojava. Pojavljuju se samo na nosačima sa silikatnim staklom, a kataliziraju ih vrlo blage promjene temperature koje se ne mogu spriječiti u prostorijama u koje ulaze ljudi. Jedina preventivna mjera je zamjena stakla materijalom koji je manje osjetljiv na temperaturu. Takva druga mogućnost koja je iskušana u muzejima je plexiglass®, pri čemu treba pomno uravnotežiti prednosti i mane takvog odabira. Utjecaj migracije čestica od kojih se sastoje naslage, kao konzervatorski problem, dosad nije istražen, a čini se da je zanemariv, budući da ne postoji razlika u tim česticama, bilo da potječu iz materijala od kojih se sastoji nosač ili iz samog predmeta, i dosad nisu prijavljeni nikakvi konzervatorski problemi.