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Technical Note

Application of the Non-woven Viscose Fabric Paraprint OL 60 for Float Screen Washing of Documents Damaged by Iron Gall Ink Corrosion

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Introduction

One of the most important document collections at the Universitätsbibliothek Marburg consists of the scientific estate of the jurist Friedrich Carl von Savigny (1779–1861).[1] Savigny was a professor of law in Marburg from 1803–1808. After teaching in Berlin for a long time, Savigny was appointed Prussian minister of law revision in 1842. He was in close contact with scholars of archaeology and mediaeval studies as well as with representatives of the German Romantic Movement. His circle of friends and relatives included among others Bettina von Arnim, Clemens Brentano, the Grimm Brothers and Stephan August Winkelmann. The Savigny collection is used intensively for jurisprudential studies as well as for research and editorial projects in the humanities or the history of science.

In 1998, the digitization of this estate was made possible by the Deutsche Forschungsgemeinschaft (DFG). The project also involved upgrading storage and carrying out a condition survey. The documents that were created between 1787 and 1867, were almost exclusively written with iron gall inks, and display ink corrosion in various stages. The condition survey revealed that approximately 34% of the letters and almost 27% of the manuscripts – all in all there are 6,574 sheets – show dark brown discolouration on the verso of the ink inscripition as obvious signs of damage. Severe mechanical damage caused by the ink corrosion, recognizable by cracks and losses in the inked areas, occur in about 1% of the surveyed inventory – all in all 196 sheets.[2] The collection includes letters from almost 700 different writers; it features different paper qualities and ink compositions.

On the basis of the survey results, in 2004 the Universitätsbibliothek Marburg began a large-scale conservation project. They were supported by the paper conservation graduate program *Konservierung und Restaurierung von Graphik, Archiv- und Bibliotheksgut* at the *Staatliche Akademie der Bildenden Künste Stuttgart* within the context of this second DFG project.[3] One of the goals of the project has been to

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develop a standardised and effective aqueous ink corrosion treatment process that would involve the application of a calcium phytate solution to single sheets.

It is known that the treatment involving a calcium phytate and calcium hydrogen carbonate application removes soluble degradation products or acidic components from paper; further, calciumphytate acts as an antioxidant and calcium carbonate slows down the mechanisms causing the ink corrosion Both thereby help to protect objects significantly from future deterioration.[4, 5, 6, 7] At the same time, this treatment is a significant intervention that alters the characteristic material composition and consistency of the original paper and ink materials. To be able to make informed decisions about the benefits and risks of such a treatment, a detailed description and evaluation of the treatment was carried out that resulted in the formulation of parameters for the application of the phytate treatment. The current contribution describes one aspect of this process, namely the considerations that went into developing a practical treatment such that took into account the benefits and risks of float washing documents suffering from iron gall ink corrosion. In order to reduce mechanical stress on the objects, the viscose non-woven fabric Paraprint OL 60 served as support material and was combined with the float screen washing method. The risk of causing the uncontrolled migration of dissolved coloured components or mechanical damage to the paper in the areas of ink inscription could thus be minimised.

Specific Risks of Aqueous Treatment Associated with Ink Corrosion

Any aqueous treatment of severely corroded iron gall ink documents, those rated as 3 and 4 according the condition rating scheme published by Reißland und Hofenk de Graaff,[8] presents two primary hazards: an increased risk of damaging the paper substrate physically, and the danger of incurring bleeding in the ink lines. Cracks and loss of material occur due to the different water response of different areas within the document. The areas of the paper support beneath the ink lines, the areas next to the lines, and the blank paper show different wetting characteristics and swelling that relate to the different states of cellulose degradation due to hydrolysis and oxidation. When the paper is wetted, tensions build in it and as a result, its weakest part, i.e. the corroded ink areas, are physically stressed. In the worst case, this leads to the formation of cracks in the degraded cellulose in the ink inscription. The area of the ink lines often is hydrophobic while the adjacent areas are very hydrophylic. These wettable areas absorb water and also absorb soluble components of the inks and the degradation products that migrate out of the ink lines. The amount of soluble discolouration in documents carrying iron gall ink increases with the degradation of the ink and the paper support.

Requirements for the treatment technique

The Savigny estate documents were to be treated in such a way as to minimise the risks of mechanical damage or ink migration as much as possible. This was achieved by using a single sheet treatment employing a float washing procedure that was developed and tested during this project. This treatment was flexible in that it allowed a number of adjustments to be made during the course of treatment, for example, in its duration, depending on the composition and condition of the document. In the future, risk assessment and evaluation of treatment effectiveness will be supported by a process control.[9] One principle factor in reducing the treatment risk consisted of minimizing any movement of the sheet throughout the entire washing process. The treatment also had to ensure that dissolved coloured degradation products from the ink and paper would be transported evenly out of the paper. Further, the treatment had to be efficient, and it had to offer a maximum of mechanical protection even for thin writing papers with an average grammage of 40 g/m². These criteria were met thorough the combination of the Paraprint OL 60 fabric with the float screen washing method; this washing technique involves supporting the object on a screen that keeps it afloat on the water surface.

Paraprint OL 60

The viscose non-woven fabric Paraprint OL 60 (manufactured by Lohman Vliesstoffe GmbH) was introduced into conservation in 2001 by Susanne Kirchner[10] for the wet cleaning of water-sensitive paper objects carrying coloured media. Using the Paraprint fabric, these objects were exposed only on their reverse to streaming water passing through a capillary unit.[11,12] Paraprint OL 60 is a 100% alkaline-resistant 100% viscose non-woven fabric reinforced by acrylate binders. It has a weight per unit area of 60g/m² and a pH of 3.5–6.5 at a temperature of 20°C.[13] Originally, it was designed for coolant filtration and wound treatment. Kirchner lists the features of this non-woven fabric that make it interesting for conservation:

- strong capillary action
- high diffusion rate
- high wet strength
- physical stability.

The high rate of diffusion is due to the pore size in the swollen viscose fibre web which can be e.g. up to 25 times higher in viscose non-wovens than in blotting

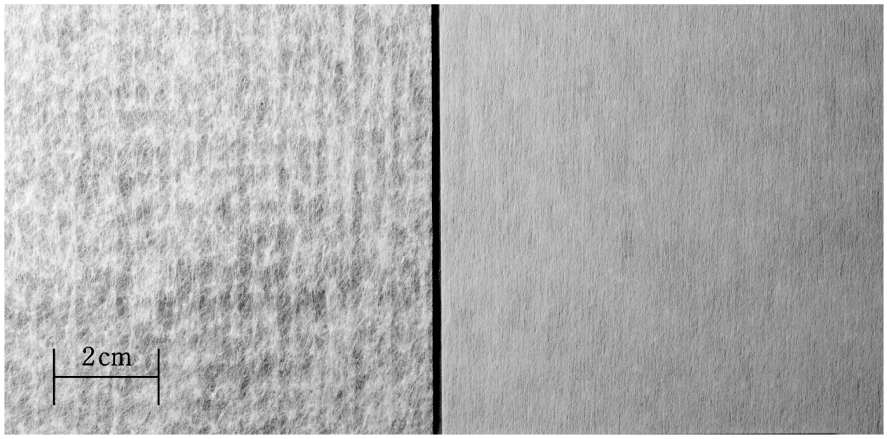

Fig. 1 Comparison of polypropylene non-woven fabric (left) and viscose non-woven fabric (right) in raking light.

paper. By the capillary action of the thin viscose fibres, discolouration products are removed from the object that lies in contact with the fabric; this prevents the dissolved compounds to migrate back into the paper. The good wet strength of the material make it an ideal intermediate support for aqueous treatments. In comparison to the randomly spun polypropylene non-woven fabric that is distributed by Per Laurson and is also often used for washing, the viscose fabric has an directional, dense and homogenous fibre structure and a smooth surface (Fig. 1).

Float Screen Washing

Washing objects by floating them on the surface of water was introduced in 1986 by Laura J. Stirton at the 10th Anniversary Conference of the Institute of Paper Conservation (IPC) in Oxford.[14] This technique involves the use of two screen frames placed on top of each other and it is particularly suitable for mechanically damaged objects. One particular advantage is that objects can be laid on the reverse side of the supporting frame so that they rest as if in a tray. This makes it possible for the conservator to create a small suction during treatment while lifting the upper frame and makes it also possible for fragile sheets to be easily transferred from one to the next treatment step (Fig. 2).

Even if they have a hollow core, metal frames as originally used by Stirton tend not to float on the water surface. Thus the depth of the liquid has to be adjusted on the same level with the screen surface that is to carry the object. The screen

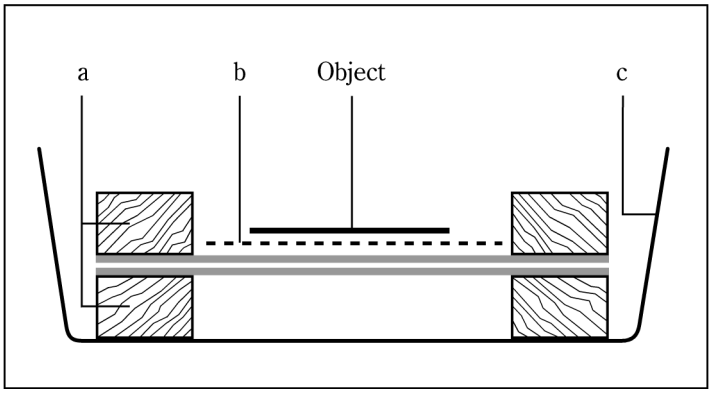

Fig. 2 Set up of the *float screen washing* method: (a) two screens with their webs touching, (b) non-woven material as secondary support for the object, (c) tray.

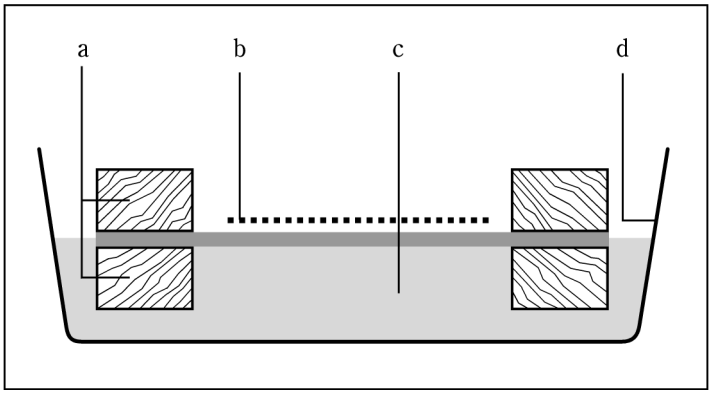

Fig. 3 Position of the wooden frames in the bath: (a) two overlying frames, (b) treatment device consisting of an object placed in a nonwoven sandwich, (c) solution for treat-ment, (d) tray.

and the Paraprint fabric have to be in contact with the water surface. The wooden frame construction was waterproofed with polyurethane and furnished with a silk screen-printing fabric. The wood causes the screens to float on the water surface (Fig. 3).[15]

Using the double frame set-up that was key already to Stirton's system, the washing action can be intensified through a specific movement of the upper frame. While resting at the water surface, the two screens lie in contact. By lifting and lowering the upper frame with the object, suction is generated which causes water to be drawn downward. This encourages the transport of water out of the back of

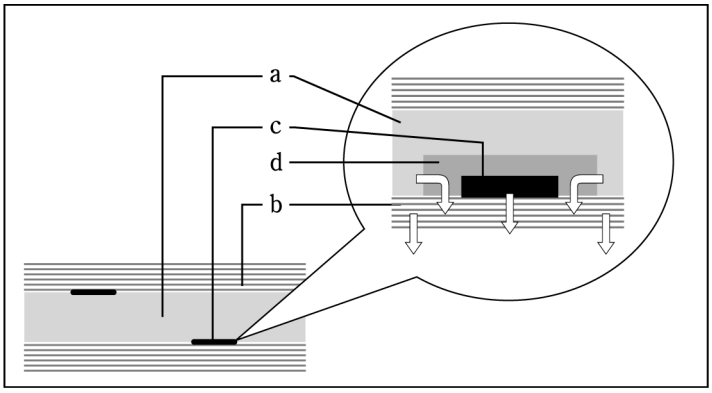

Fig. 4 Model of the diffusion processes in the bath: The sheet carrying ink on both sides (a) is placed between two viscose fabrics (b). Soluble components from the ink (c) and from the degradated areas around the ink (d) are transported into the water due to the capillary force of the non-woven material.

the paper. Dissolved products from the paper are thereby quickly transferred into the surrounding solution.

Application of the Paraprint Fabric in Combination with Float Screen Washing

In combination with the double screen system, the viscose non-woven Paraprint OL 60 optimizes the treatment. The permeable fabric enhances the diffusion of dissolved degradation products out of the paper and ensures even penetration of the treatment solution into the paper. For documents carrying writing on both sides, a sandwich of two Paraprint sheets has proven successful. Soluble products that leach out of either side of the paper are thus prevented from migrating and redepositing into the absorbent paper areas. Instead, the dissolved products are carried away by the fabric lying in contact with the paper and are transported into the bath solution (Fig. 4). Float screen washing also allows the conservator to adjust the permeation of water into the paper manually because the frame can be lifted and lowered as needed. At the same time, the frame, being a rigid support, stabilizes the paper, and even if the screen is pushed under the water surface, it reduces the movement of the paper.

In preparation for washing, the viscose fabric is cut to the inner frame dimensions, also taking into account the fact that the fabric expands transverse to the fibre direction. The fabric and the object are placed in the humidification chamber. Humidification and subsequent misting water-alcohol solution allow slow and ho-

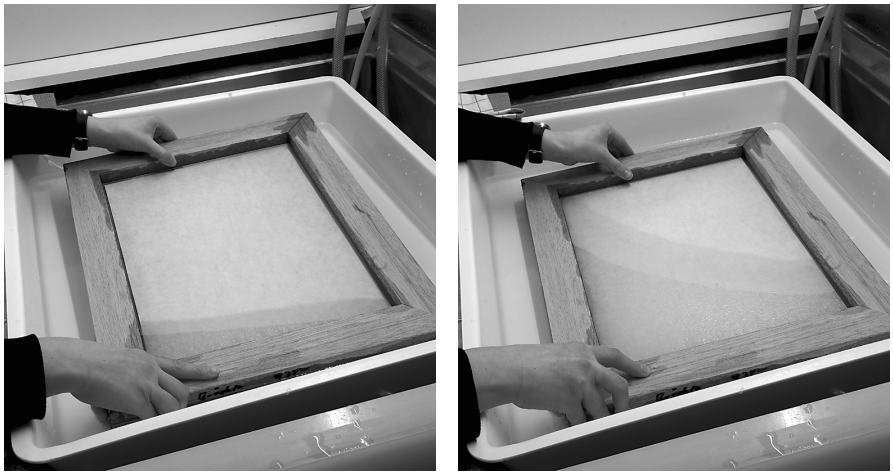

Fig. 5 The beginning of wetting: frame with humidified viscose fabric with gradually (left) and advanced (right) permeating water film.

mogenous dampening of the object. The gradual moisture conditioning facilitates the tension-free expansion of the ink-corroded document as is needed before it can be transferred into the liquid water. From the beginning of the float washing treatment, the paper object lies on the reverse of the upper frame, supported on the smooth side of the viscose fabric. The second frame lies in the bath with the screen facing upwards. Starting at one of the short edges, the frame carrying the object is then placed on the second frame in a slightly slanting position (Fig. 5).

The lower screen is pushed upwards to generate a water film on the surface of the webbing. The upper screen is slowly lowered so it comes into contact with it. Water then begins to penetrate the fabric evenly. Not too much liquid should be in the tray so that the sheet remains on the screen and all of its movements can be controlled easily. The water absorbed by the viscose fabrics is transferred immediately to the pre-wetted sheet. Water penetration ends when the screen and the viscose fabrics are filled with water. The viscose fabric ensures a very fast and smooth penetration through the screen as it is slowly placed in the water. When lifting the screen, much of the water held in the fabric is released evenly and quickly because its pores are quite large. The fact that the original object is protected on both sides by a porous rigid screen frame makes it possible to remove excess solution from it without touching it (Fig. 6). This can be done whenever one decides to end the aqueous treatment baths.

During the treatment, the forces of the water are acting visibly on the fabric, screen and sheet, causing an intensive adhesion force between the respective contact surfaces. Due to the open surface and flexible and permeable structure of the

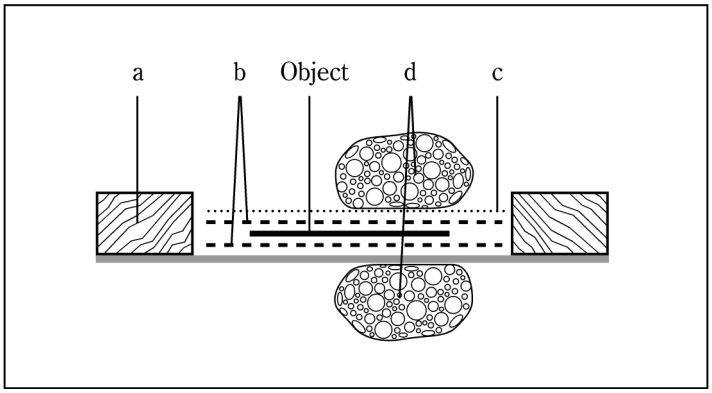

Fig. 6: Removing excess solution from the treatment unit: (a) frame, (b) viscose non-woven sandwich, (c) flexible screen as protective support, (d) absorbent cloth – removes the excess water at the top and at the lower side.

Fig. 7: Screen with capillary fabric and inked sheet: When lowering the upper frame, the treatment solution enters the sheet via the non-woven fabric. The water film causes an intensive adhesion between the materials.

fabric, the object remains fixed in its original position on the frame, even when the frame is placed in a slant position (Fig. 7).

The high permeability of the viscose fabric makes wetting more even because it has the tendency to float on the water surface and thereby also lift the object, which is a problem observed with the hydrophobic polyester fabric Hollytex®. The regularly repeated movement of the screen and the resulting suction enhance the effectiveness of the washing process.

Resumé

Treatment of single sheets by float screen washing in combination with the capillary non-woven fabric Paraprint OL 60 offers an effective mechanical protection for fragile papers. The advantages of this method for the aqueous treatment of documents damaged by ink corrosion are

- protection of the manuscript through a rigid support and an intensively adherent fabric underlying the object and reducing the movement of the sheet
- control of the penetration of the treatment solution due to the screen movement
- adjustment of the treatment to the condition of fragile objects
- controllable suction through subtle movement of the frame
- quick removal of soluble degradation products.

The treatment of manuscripts severely damaged by ink corrosion to the point of embrittlement and cracks always bears the risk of further material loss or other disturbing changes. By using the float or sandwich washing technique introduced above, the risks of mechanical strain and migration of ink components are minimised.

Acknowledgements

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Summaries

Technical Note: Application of the non-woven viscose fabric Paraprint OL 60 for float screen washing of documents damaged by iron gall ink corrosion

For the treatment of restoration using the aqueous calcium phytate-calcium hydrogen carbonate-treatment, an improved version of the already existing method of *water screen bathing* has been developed and successfully tested for the serial single sheet treatment of thin manuscripts damaged by ink corrosion. Due to this technique, there is relatively little mechanical strain on the object. Bleeding along the inked lines is prevented, because the sheet is lying on the frame along

with the capillary non-woven tissues which support the transport of water. A homogenous and effective result of treatment is reached in regard to aqueous treatment. The object is mechanically supported by lying on a frame throughout the entire aqueous treatment.

Note technique: Utilisation de viscose non-tissée Paraprint OL 60 dans la méthode du « Water Screen Bathing » pour le traitement de documents manuscrits corrodés par l'encre gallique

Pour la méthode de restauration appliquant le traitement aqueux au phytate de calcium-carbonate hydrogène de calcium la technique déjà connue du *water screen bathing* a été développée dans une nouvelle variante et testée avec succès pour le traitement en série de feuilles individuelles manuscrites endommagées par la corrosion de l'encre. Cette technique provoque relativement peu d'effets secondaires néfastes sur l'objet traité. La formation de taches le long des contours des lignes d'encre est empêchée par le fait que la feuille de papier repose sur la viscose non-tissée dont les capillaires absorbent l'eau. Par rapport au traitement aqueux on obtient un résultat homogène et effectif sur la feuille de papier. Pendant toute la durée du traitement aqueux l'objet repose sur un cadre de tamisage.

Kurzmitteilung: Der Einsatz des Viskosevlieses Paraprint OL 60 bei der Float Screen Wässerungsmethode zur Behandlung tintenfraßgeschädigter Handschriften

Für die restauratorische Anwendung der wässrigen Calciumphytat-Calciumhydrogencarbonat-Behandlung wurde die bereits bekannte Methode der float screen Wässerung in einer neuen Variante weiter entwickelt und erfolgreich für die serielle Einzelblattbehandlung von dünnen tintenfraßgeschädigten Briefpapieren erprobt. Durch die Technik wirken relativ geringe mechanische Belastungen auf das Objekt ein. Indem das Blatt zusammen mit den Wassertransport fördernden Kapillarvliesen auf den Siebrahmen liegt werden Hofbildungen entlang der Tintenlinien verhindert. In Bezug auf die Wässerungsvorgänge im Blatt wird ein homogenes und effektives Behandlungsergebnis erzielt. Während der gesamten wässrigen Behandlung wird das Objekt auf einem Siebrahmen liegend mechanisch gestützt.

Material

Paraprint OL 60, 100% viscose non-woven fabric, acrylate binder reinforced, 60g/m², pH 3.5-6.5 at 20°C, alkaline resistant. Application for medical treatment (e.g. support for plaster fabrics, nursing pads, screens used during operations etc.), as coolant filtration, coating support (e.g. for the shoe industry and other applications), for cleaning cloths (e.g. antistatic cleaning cloths in the data processing area).

Producer
Lohmann Vliesstoffe GmbH & Co KG, Dierdorf/ Germany,
www.vliesstoffe-dierdorf.de

Suppliers
Belo Restaurierungsgeräte GmbH, Wiesenstr. 14, 79585 Steinen, Germany,
Phone: +49-(0) 7627-1703, Fax: +49-(0) 7627-972084
http://www.belo-restauro.de/
belogmbh@aol.de
Capillary non-woven fabric Paraprint OL 60, 1200 mm wide, 7 m per role/ minimum purchase.

GMW-Gabi Kleindorfer, Aster Str. 9, 84186 Vilsheim, Germany,
Phone: +49-(0) 8706-1094, Fax: +49-(0) 8706-559
http://www.gmw-gabikleindorfer.de
non-woven fabric Paraprint OL 60, 100 m role, order number 37 060.

References

1 Further information on the estate as well as the documents of the Savigny database of the Universitätsbibliothek Marburg can be found at http://www.uni-marburg.de/bis/ueber_uns/ub/sondsam/savigny.

2 Hähner, U.: *Condition Report of the Ink Corrosion Damage in the Handwritten Estate of the Jurist Friedrich Carl von Savigny within the Scope of a Digitalisation Project.* Restaurator 27 (2006): 131–142.

3 A detailed overview of work contents, participants and co-operation partners of the DFG-project can be found at http://www.uni-marburg.de/bis/ueber_uns/ub/dfgtinte/index .

4 Neevel, J. G.: *(Im)possibilities of the Phytate Treatment of Ink Corrosion.* In: Contributions to Conservation. Research in Conservation at the Netherlands Institute for Cultural Heritage (ICN), A. Mosk, J. A. und Tennent, N. H. (eds.), London (2002): 74–86.

5 Reißland, B.: *Neue Restaurierungsmethoden für Tintenfraß auf Papier mit wässrigen Phytatlösungen. Möglichkeiten und Grenzen.* In: Tintenfraßschäden und ihre Behandlung. Banik, G. und Weber, H. (eds.), Werkhefte der Staatlichen Archivverwaltung Baden-Württemberg, Serie A, Heft 10, Stuttgart, Verlag Kohlhammer (1999): 113–220.

6 Banik, G., Kolbe, G. and Wouters, J.: *Analytical Procedures to Evaluate Conservation Treatments of Iron Gall Ink Corrosion.* In: La conservation à l'ére du numérique. Actes des quatrièmes journées internationales d'études de l' association pour la recherche scientifique sur les arts graphiques (arsag). Paris, 27.–30. Mai 2002, arsag (ed.), Paris (2002): 205-217.

7 Kolar, J., Šala, M., Strlič, M. and Šelih, V. S.: *Stabilisation of Paper Containing Iron-Gall Ink with Current Aqueous Processes.* Restaurator 26 (2005): 181–189.

8 Reißland, B. and Hofenk de Graaff, J.: *Zustandsklassifizierung für Papierobjekte mit Eisengallustinten-aufträgen.* ICN-Information Nr. 1, Instituut Collectie Nederland, Amsterdam: 2000.

9 A detailed overview with the work contents, including the process control, will be accessible at the end of 2007 within the final report on the project at http://www.uni-marburg.de/bis/ueber_uns/ub/dfgtinte/index .

10 Kirchner, S.: Kapillarreinigung. *Eine schonende Methode der Feuchtreinigung in der Papierrestaurierung.* PapierRestaurierung 2, Suppl. (2001): 73–80.

11 Zajicek, P. and Tinwell, D.: *A Cleaning Method and Apparatus.* Australien Patent Application 644215, (1990).

12 Chantry, J.: *The capillary unit. A workshop aid to the conservation of water-sensitive items.* Paper Conservation News 68 (1993): 11.

13 Letschert, T . Personal communication Lohmann Vliesstoffe/TWE, Dierdorf: 3. Feb. 2006.

14 Stirton, L. J.: *Winterthur Water Screen Bathing.* Technical Note. Paper Conservation News 42, Juni (1987): 3–4.

15 This frame construction made from wood was originally conceived by Olivier Masson, Zürich, Switzerland. A similar screen was used by Irene Brückle and Gerhard Banik in their workshop *Water in paper: principle mechanisms*, held 11.–14. January 2005 at the Staatliche Akademie der Bildenden Künste Stuttgart.

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