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METAL*Consn*-info

Metal working group

Bulletin of the Research On MEtal Conservation

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BROMEC 1

Editorial

After the announcement of the publication of the BROMEC some months ago, here is the first issue. Just before Christmas, my task has been to promote the idea of the bulletin and to find correspondents in different countries. Until now most of the countries represented are in the European Community but we hope that in the future other countries will contribute to the development of our bulletin.

For those discovering the BROMEC for the first time, we remind you that it benefits from the support of ICOM-CC Metal Working Group. Some of you might wonder then why not using the Group Newsletter to diffuse the following information. The objectives are just different: we expect to inform regularly (4 times per year, every 3 months) the conservation community on the progress of research in metal conservation. The projects presented can be implemented in research institutions or in conservation laboratories. Short studies conducted by conservation students or students from other fields (archaeology, chemistry, physics) are welcome. Because the outcomes of such works are rarely published, the BROMEC could be the medium to promote them.

The BROMEC is structured around four themes:
- research projects already achieved with outcomes currently applied in the field but which need optimisation
- ongoing research projects
- new research projects
- other information (seminars, workshops, web-sites) specific to the conservation of metals

All the data given in the bulletin are provided by the editor and the correspondents from the following countries (e-mail addresses and phone numbers are given at the end of the bulletin):

- **Belgium**: Patrick Storme, conservator and lecturer at the Hogeschool Antwerpen, Royal Academy of Fine Art, Antwerpen and Gilberte Dewanckel, conservator at IRPA (Institut Royal du patrimoine artistique), Bruxelles
- **Denmark**: Karen Stemann Petersen, conservator, The National Museum of Denmark, Copenhagen
- **Germany**: Gerhard Eggert, head, study program "Object Conservation", Staatliche Akademie der Bildenden Künste, Stuttgart

- **Greece**: Vasilike Argyropoulos, assistant professor, Department of Conservation of Works of Art, Technological Educational Institution, Athens
- **Italy**: Paola Letardi, scientist at the Istituto per la corrosione marina dei metalli (ICMM), Genova
- **Netherlands**: Bart Ankersmit, conservation scientist, The Netherlands Institute of Cultural Heritage, Amsterdam
- **Norway**: Birgit Wilster-Hansen, conservator, University Museums of Cultural Heritage, University of Oslo, Oslo
- **Sweden**: Helena Strandberg, conservator and conservator scientist, freelancer, Göteborg
- **Switzerland**: Valentin Boissonnas, conservator and lecturer at the conservation school HEAA, La Chaux-de-Fonds
- **United Kingdom**: David Thickett, conservation scientist, conservation department of the British Museum, London

Help Desk
Comment:

The correspondents have two main tasks: first they gather all the information (research projects, announcements…) given to them by professionals of their country. In addition they constitute a list of e-mail addresses of professionals who are interested in receiving the BROMEC. This list has to be regularly up-dated and then sent to the editor. Since information on research projects are not easy to obtain, most correspondents are conservation scientists involved in metal conservation or metal conservators involved in research, both being strongly connected to the conservation profession. Of course all new correspondent from another country than the ones mentioned above are welcome. Please contact the editor to join the group of active correspondents.

The BROMEC will be issued through internet to avoid mailing expenses and limit the costs to the minimum. Research projects and new outcomes in long-term studies are presented briefly. More information can be obtained directly from the contributor(s) whose details (name of institution and e-mail address) are given with abbreviations and acronyms at the end of the bulletin. English is the official language.

I hope that you will enjoy the reading of this bulletin and that you will participate actively to its promotion and development.

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Applied research projects

 Application of pulsed currents to the stabilisation of small iron artefacts (***EVTEK Institute of Art and Design***)

The conservation laboratory, Arc´Antique and the LEPMI (France) conducted in 2000 a research project on the improvement of the stabilisation of iron artefacts using pulsed currents (submitted to Studies in Conservation). The principle is that the current going through an artefact polarised cathodically is switched off regularly so that fast reactions (extraction of chlorides) are favoured and slow processes (evolution of hydrogen) restricted. As a consequence less damage is expected at the surface of the metal.

This technique has been applied with success on a group of grey cast iron bullets from a grape-shot which after dismantling had been left drying without treatment. Because of the high currents needed at the beginning of the stabilisation process in KOH 1% (w/v) only a basic generator was needed. But at the end of the process very low current values were required to keep the cathodic potential at a stable value (-0,9V/ESS). Since no potentiostat was available, the only possibility we had to limit the evolution of hydrogen was to use with our generator a timer to switch off the current regularly. Different cycles on / off were tested until we obtained the optimal one.

This study was part of a preliminary project conducted by Ebba Samuelsson, student of the Marine Archaeological Course, EVTEK Institute of Art and Design. The use of the pulsed currents concept appeared quite promising finally since no damage was observed although our generator was initially thought to be too drastic.

Contact: Christian Degrigny (EVTEK Institute of Art and Design)
Funding: no external funding

Applied research projects

 In-situ conservation of grey cast iron cannon (***EVTEK Institute of Art and Design / MMF***)

In the past few years the wreck of Gustav Adolf (1788, outside Helsinki) has provided Finnish sports divers and marine archaeological researchers with a valuable insight to a late 18th century Swedish war ship. The wreck has been made accessible to sports divers in the summer of 2000. This opening brings conservation problems: how the artefacts will survive with time?

The Maritime Museum of Finland (MMF) which is responsible of the site has decided to monitor first the damage occurring on the cannons (40 in total) due both to the environment and accidental human disrespect. One student from the Marine Archaeological Conservation Course, EVTEK Institute of Art and Design (Rami Kokko) has begun a survey on a selection of cannons (internship report). Because of the short diving season in Finland, only some documentation work has been possible until now.

In parallel Rami Kokko has conducted some experiments at the Maritime Museum Conservation Laboratory to simulate the behaviour of grey cast iron artefacts in conditions similar to the ones found on the Gustav Adolf wreck. E_{corr} (corrosion potential) was monitored with time on artefacts just immersed or cathodically protected with sacrificial anodes. Both the presence of marine crust and the daily renewing of the marine solution were studied. The objective in the long term is to be able to interpret E_{corr} values measured in situ. According to the results obtained the decision to protect the cannons with sacrificial anodes might be taken [1,2]

Further research is planned during the next summer season.

[1]: MacLeod I., The International Journal of Nautical Archaeology (1995) 24.1:53-59
[2]: Gregory D., The International Journal of Nautical Archaeology (1999) 28.2:164-173

Contacts: Christian Degrigny and Rami Kokko (EVTEK Institute of Art and Design)
Funding: MMF

Applied research projects

 Plastiline as cause of "black spots" on bronzes (***SABKS***)

The equilibrium vapour pressure (some 1ppb) of elemental sulphur is sufficient to produce a Cu-S-efflorescence on bronzes ("black spots"); it can occur not only in mineralogical collections, but also in marine crusts on metals or in waterlogged wood from anaerobic sites [1].

Recently, "black spots" have been observed on both sides of a copper alloy fibula which was mounted with an unknown brand of modelling clay ("plastiline") in a South German museum. This compound can contain large amounts of elemental sulphur (in one recipe 23 %!). Although it is known to trained conservators that modelling clays can tarnish silver, this seems not to have found its way into textbooks. Sulphur containing brands should be totally banned from conservation labs for any purpose. Sulphur can easily be detected by heating a sample in a small reagent tube covered with a wetted lead acetate paper. This indicates the thermally generated hydrogen sulphide from elemental sulphur and organic bound hydrogen by the formation of brown to black lead sulphide on the paper.

Any further reference to long time experiences with the effect of modelling clays to metals would be welcome.

[1]: Eggert, G. & Sobottka-Braun, U., ICOM CC 12th Triennial Meeting Lyon (1999) 823-827

Contact: Gerhard Eggert (SABKS)
Funding: SABKS

Ongoing research projects

 D.C. mode hydrogen plasma treatment for archaeological iron (***VCCW / Department of conservation, DNM***)

Since 1997 D.C. mode hydrogen plasma has been tested in Viborg County Conservation Workshop as a conservation method for highly chlorinated archaeological iron. This work is a further development of previous research conducted in Denmark since 1985 [1] where the artefact has been connected as cathode to improve the efficiency of the desalination.

The apparatus used consists of a D.C. power unit (0-3A, 0-2000V) equipped with a vacuum unit. The electrode arrangement consists of a big tubular anode and a smaller tubular cathode, which can be switched off from the electrical system. Inside the tubular cathode is a mesh tray, which is also a cathode. The mesh tray carries the objects to be treated.

When placed on the cathodic mesh tray, the artefact (even when covered with a heavy corrosion crust) gains true cathodic potential after a short time covered in plasma. Due to changes in particle flux the reductive effect of the process is dramatically enlarged, when the cathodic potential of the artefact is achieved.

Until now a number of different aspects have been investigated, such as: process parameters; chamber temperatures and pressure variations during the treatment; changes of electrical properties of objects; stability in humid chamber of treated and untreated objects and effect of the plasma treatment on the desalination of objects in aqueous solutions.

Although the reduction of corrosion products seems to be fast and efficient, the transport of chlorides from the objects during the plasma treatment seems to be rather slow. Often plasma treated artefacts show an extensive formation of akaganeite crystals after short-term exposure to normal indoor humidity. This indicates that short plasma treatments alone might result in decreased stability of the artefacts. On the other hand the effects of the short plasma treatment is valuable when a desalination process is conducted afterwards. This is illustrated by the fact that objects, which were considered stable after five years of alkaline washing in 0.01M NaOH (with weekly washing cycles), liberate considerable amounts of chloride after plasma treatment and renewed washing.

Our objective now is to determine the amount of chloride left in the structure after plasma treatment and following alkaline washing. To get reliable results, the analysis will be conducted on a large number of artefacts. Dissolution in nitric acid of sacrificial artefacts is planned although the detection of small amounts of chlorides in extremely acidic solutions might be a problem.

[1]: Sjøgren A. & Buchwald V.F., Studies in Conservation 326 (1991) 161-171

Contacts: Lars Andersen, Ove Madsen, Jesper Søbjørn Jensen (VCCW) & Birgit Sørensen (Department of Conservation, NMD)
Funding: SM Board, Denmark & VCM Council

Ongoing research projects

 Investigation on the use of a Nd:YAG laser for the removal of corrosion products on archaeological iron (***HEAA / Laser Institut der Fachhochschule Münster)***

The aim of this research project was to find out if laser cleaning can remove external corrosion products of archaeological iron, and at the same time, expose the original surface more carefully as can be achieved by traditional air-abrasive methods. This research has been the subject of the dissertation of Jenny Studer, student at HEAA, La Chaux-de-Fonds, Switzerland.

A new kind of Nd:YAG laser system with four different wavelengths (1064nm, 532nm, 355nm, 266nm) was used and applied to original archaeological objects. The investigation dealt in particular with the influence of the wavelengths used, the amount of corrosion removal, the colour change, the temperature analysis of the irradiated surfaces and the analysis of the corrosion products before and after treatment. The modification of the original surface and removal thresholds of the corrosion products were determined by taking reflection spectrums of the different corrosion layers.

The effects of various energy densities and irradiation lengths were analysed under a binocular microscope as well as a scanning electron microscope. Larger irradiated surfaces were compared to sandblasted surfaces. One object (a fibula) with original surface details was completely and successfully cleaned by the use of the laser.

The result of this research shows that the wavelength of 1064nm with this laser system can remove most external corrosion products (preferably after a first traditional removal of bulky corrosion layers with air-abrasive). The efficiency can be increased when the surface is wet. Grains of quartz and calcium-silica deposits within the corrosion products do not absorb, but reflect the laser beam within this wavelength range. However, when moistened with ethanol, and while using higher energy densities, such surface deposits can be successfully removed. It was shown, that laser cleaning can reveal surface details without harming the original surface. Nevertheless, the surface is darkened by the irradiation and melting points can occur. With 355nm and 532nm such melted areas remain invisible to the eye. More important, the laser cleaning does not change the internal metallurgical structure by high temperatures, as the pulse lengths are extremely short.

Contact: Jenny Studer (HEAA)
Funding: DBU

Ongoing research projects

 Copper sulphide corrosion on copper based alloys and minerals (***SABKS / MRT / ICN***)

Copper sulphide corrosion on museum objects made of copper alloys, more commonly known as "black spots", was first officially reported in the 1970´s [1]. Little research has yet been carried out on this subject. We know by now that the presence of elemental sulphur and reduced sulphur gases, such as hydrogen sulphide (H_2S), and carbonyl sulphide (COS) are responsible for its occurring, but the exact mechanisms of "black spot" growth are still unclear [2]. There is no sufficient information neither concerning the chemical composition of "black spots", nor about the extent of damage caused by them. The pollutant source often cannot be identified.

As part of a master dissertation in conservation (SABKS, Stuttgart) and in collaboration with the MRT and the ICN, several laboratory experiments were set up, exposing copper alloy samples to different concentrations of various sulphurous pollutants, and testing protective coatings. Corrosion products, artificially produced and obtained from museum objects, will be analysed, mainly using XRD. Air pollutant measurements in the MRT museum are hoped to shed light on the connection between corrosion rate and pollutant concentration. Surveys in museum collections (MRT and MSL) and mineralogy collections were carried out in order to document the growth patterns of "black spots", and the damage occurring on objects. The suitability of some show case materials and conservation products will be evaluated.

[1]: Brinch Madsen H., Arbeitsblätter für Restauratoren, 1/1978, Gr. 2, 96-101
[2]: Eggert G. & Sobottka-Braun U., ICOM-CC 12th Triennial Meeting, Lyon (1999) 823 - 827

Contacts: Maja Weichert, Gerhard Eggert (SABKS), Mark A. Jones (MRT) & Bart Ankersmit (ICN)
Funding: SABKS (partial)

Ongoing research projects

 Investigation of the composition of tin spoons found in Amsterdam (***ICN / AAD***)

The Archaeological department of the city of Amsterdam has over the years built a collection of 1700 tin spoons from excavations in the city. The aim of this XRF-investigation is the correlation of the elemental composition of a large amount of spoons with visual marks and archaeological data.

The initial research project indicated that the tin content varied between 82 and 99%. The relationship between the percentage of lead and the date of manufacturing appeared to be of special importance. The lead content in the alloy varied in accordance with the date of the spoon, starting with the absence of lead in very early spoons, going up to more than 15% in the latest artefacts. Antimony was only found in three spoons (1, 4 and 5%) and is believed to make the distinction between English and European tin spoons.

Contacts: Bart Ankersmit, Peter Hallebeek (ICN) & Jørgen Veerkamp (AAD)
Funding: no external funding

Ongoing research projects


The analysis of measles and a white blush on daguerreotypes (***ICN / NPCS***)

The National Photographic Conservation Studios in Rotterdam were asked to treat 124 daguerreotypes made in 1870´s in Indonesia by Adolph Schaefer. The silvered copper plates showed different stages of blushing and brown spots. The formation of these small brown spots, also called measles, on daguerreotypes are supposed to be the result of a thiourea treatment in the past [1].

Together with the ICN, the NPCS hopes to elucidate the mechanism of brown spot formation by SEM-EDS, FTIR analysis and accelerated ageing tests. The collection of plates will be studied and a proper description of the two surface phenomena will be made, since both macro and microscopic description of the measles have thus far not been made properly. The plates will be divided into groups and the representatives of these groups will be analysed. Attention will be focused on the presence of organic residues on the silver surface.

A dummy daguerreotype will be treated with thiourea and subsequently aged by xeno-light to induce photo oxidation reactions. The strips will be analysed by FTIR.

[1]: Edmondson T.M. & Barger M.S., Topics in Photographic Preservation (1993) 14-26

Contacts: Bart Ankersmit, Han Neevel, Ineke Joosten (ICN) & Hans de Herder (NPCS)
Funding: no external funding

Ongoing research projects

 In situ preservation of metal artefacts in a waterlogged environment (***Conservation Department, NMD***)

Nydam Mose in Denmark is a waterlogged meadow into which weapons were deposited during the Iron Age as sacrificial offerings. Some of the artefacts have already been excavated, but other unexcavated remains are being preserved in situ, their deterioration being under study for the last 5 years [1]. The feasibility of in situ preservation obviously depends on current deterioration rates of the archaeological artefacts in the meadow. Recently, corrosion rates on modern iron coupons showing the effects from water level changes during an archaeological excavation have been published [2]. Currently, all information from the project is being collated and will be published in 2002.

The deterioration study involves 3 approaches: investigation of excavated archaeological artefacts, investigation of modern sacrificial material placed in the meadow and investigation of environmental parameters. The state of preservation of the archaeological artefacts is estimated using X-ray photography and correlated to the exact position of the artefacts in 3 dimensions within the meadow. A large variation in state of preservation is observed by this method. The corrosion layers on iron artefacts mainly consist of siderite ($FeCO_3$). We are studying the formation mechanism of this corrosion product based on our measurements of environmental parameters in the area. We would thus be interested in any information on the formation of siderite as a corrosion product on archaeological iron artefacts. The nature of the environment would have to be precised too. We are especially interested in whether the formation of iron (III) oxides is a necessary precursor for the formation of siderite.

[1]: Sørensen B. & Gregory D., Metal 98, Proceedings of the International Conference of Metals Conservation, ICOM-CC, (1998), 94-98
[2]: Matthiesen H. et al., Proceedings from the conference on Preserving Archaeological Remains in Situ, PARIS2, Museum of London, September 2001

Contact: Henning Matthiesen (NMD)
Funding: no external funding

Ongoing research projects

 Cleaning of aged protective layers covering lead artefacts damaged in corrosive organic acid vapours (***EVTEK Institute of Art and Design / EVTEK Institute of Technology / HEAA / NMF***)

The conservation of lead artefacts damaged by corrosive acid vapours is now well controlled. Electrolytic reduction can be applied and the process is monitored by plotting log(I) = f(t) curves [1]. Some recent studies have shown that the process can even be applied in case of a composite lead / textile / parchment (case of lead seals still attached to the written document, research not published yet).

Some lead artefacts have been protected in the past by organic materials which have aged and under which active corrosion has developed. Specific cleaning protocols have to be defined. But the identification of the aged organic materials is first needed. Solvents might be used to clean them but the process has to be conducted very delicately since the original surface below is highly fragile due to the development of active corrosion.

This applied research project will focus on artefacts from storage areas of the Medals Cabinet, National Museum of Finland which have suffered from exposure to corrosive vapours a few years ago. The whole collection has been moved since but the storage areas are still unsafe.

The pollutants evolved in the storage areas will be first analysed in collaboration with the EVTEK Institute of Technology and students of the Environmental Monitoring Course. The whole collection will be then studied to assess the damage on lead artefacts. A conservation strategy will be defined to clean the objects protected or not with some organic materials. The electrolytic reduction process will be finally applied to stabilise the corrosion process.

Both the survey of the collection and the definition of a pre-cleaning treatment before the electrolytic reduction will be carried out in Spring and Summer 2002 by interns from HEAA (La Chaux-de-Fond, Switzerland) and EVTEK Institute of Art and Design.

[1]: Degrigny C. & Le Gall R., Studies in conservation 44 (1999) 157-169

Contacts: Christian Degrigny (EVTEK Institute of Art and Design), Marja-Leena Åkerman (EVTEK Institute of Technology) & Kaija Steiner-Kiljunen (NMF)
Funding: no external funding

New research projects

 Use of raman spectroscopy for the chemical identification of corrosion products produced by atmospheric corrosion of bronzes (***VUB, META department / KIK / OPD / LENS***)

In this project bronzes and their corrosion products formed by exposure to the atmosphere will be studied by Raman spectroscopy. The knowledge of product formation is important in order to optimise the conservation of cultural significant bronze. Raman spectroscopy introduces a new dimension as it combines molecular information and non-destructive character, in contrast to other techniques.

In a first part the chemical composition and the lateral and depth distribution of the corrosion products formed on different bonze alloys will be studied, using several complementary surface analysis techniques, among which Raman spectroscopy. With this information, a data bank with the Raman spectra of the corrosion products will be set up. Attention will be paid to the sensitivity of the Raman spectroscopy and efforts will be done in order to improve this sensitivity.

In a second part, the same study will be performed on bronzes of cultural importance. Using the data bank and the methods for sensitivity enhancement, the composition of bronze samples will first be determined. In a second step we will work on the possibility to develop and apply a totally in situ Raman spectroscope to the study of outdoor bronzes.

Contacts: Valérie Hayez (VUB), Helena Wouters (KIK) & Emilio Castellucci (OPD / LENS)
Funding: IWT (Institute for the Promotion of Innovation by Science and Technology in Flanders)

New research projects

Development of a method of interpretation of X-radiography pictures for the study of archaeological iron artefacts: contribution to the study of the corrosion layer and to the diagnosis (***AUSTC / UPS / IRRAP***)

Francoise Mielcarek, conservator specialised in the conservation of archaeological metals and composites has just begun a PhD on the construction of both a vocabulary describing X-radiography pictures and a method for their interpretation.

This PhD in Archaeology from the University of Paris-Sorbonne is conducted under the supervision of Mr C. Volfovsky and Mr. R. Bertholon. It will concentrate on medieval artefacts of the Archaeological Unit of St Denis city and X-radiography pictures already implemented at IRRAP, Compiègne.

More information will be given later.

Contact: Françoise Mielcarek (IRRAP)
Funding: ?

New research projects

 Technological investigation of a romanesque reliquary (***SABKS / MIUW / FHA / EDP***)

The Vitus reliquary from Willebadessen, a former Benedictine monastery near Paderborn, Westphalia, Germany, has not yet been sufficiently investigated neither from an art-historical, nor from a scientific point of view. There is no detailed information concerning provenance, dating, and subsequent alteration / reparation.

The reliquary consists of an oak case, decorated with chased gilt silver sheet, enamelled copper sheet (émail champlevé), and nielloed silver sheet.

Scientific analysis, carried out in collaboration between the SABKS, the MIUW and the FHA shall clarify questions of dating, provenance, and historical originality of the constructive parts. Methods applied are AAS, Electron Microprobe, and CT. These topics conducted as part of a master dissertation in conservation (SABKS) are also discussed with art historians of the EDP and other institutions; comparable objects shall be identified.

On the basis of the research results, the craft techniques used are to be reconstructed in detail, and are discussed against the background of the technical literature of the time.

Contacts: Heiner Grieb, Gerhard Eggert & Ernst-Ludwig Richter (SABKS)
Funding: SABKS (partial)

New research projects

Literature study of active corrosion phenomena on archaeological iron artefacts: definition of the active corrosion concept and characterisation of its symptoms (***UPS / IRRAP***)

Iron archaeological artefacts are unstable in the atmosphere once excavated. The corrosion products react with the atmosphere and H_2O adsorbed on their surface, reactivating then the corrosion process. For conservators, active corrosion is a general term which corresponds to different phenomena conducting to different corrosion structures which origin is often unknown.

This active corrosion is partly due to the transformation in the atmosphere of hygroscopic iron chlorinated compounds in more voluminous compounds which provoke then a cracking of the superficial corrosion layers. This process favours the metal corrosion according to a cycling mechanism and ends in the destruction of the artefact. But several studies in the conservation field have shown that the diagnostic and the treatment of such a corrosion is quite often uncertain.

The objective of our study will be then to conduct a survey on the general definition of active corrosion on iron objects, not only in the conservation field but in corrosion science. It will be based on a critical review of the literature. Different questions will be approached:

- the name given to such a corrosion
- the discriminative parameters observed (different kind of damages recorded)
- the description of the phenomena and the synthesis of the different corrosion mechanisms proposed
- a proposal of a definition for such a corrosion

In addition to the literature study, a questionnaire will be sent to different conservators to assess the general knowledge on that subject and the way it is used.

This research project is conducted by Marie-Anne Loeper, metal conservator at IRRAP to get a DEA diploma in the speciality “Archaeology of Historic Periods”. This work is supervised as before by C. Volfovsky and R. Bertholon.

Contact: Marie-Anne Loeper (IRRAP)
Funding: no external funding

General information

- Web-sites

Some sites offer interesting information on research applied to the conservation field. Studies on metals might be found.

- **Laboratories on Science and Technology for the conservation of European Cultural Heritage**
  http://www.chm.unipg.it/chimgen/LabS-TECH.html

- **Cost Action G8: Non destructive analysis and testing of museum objects**
  http://srs.dl.ac.uk/arch/cost-g8

- **Cost Action G7: Artwork conservation by laser**
  http://alpha1.infim.ro/cost

- Future seminars and conferences

- **5th European Commission Conference on Research for Protection, Conservation and Enhancement of Cultural Heritage** (16-18 May 2002, Cracow, Poland). For more information consult the web-site of the conference at www.heritage.ceti.pl

- **ART2002** – Non destructive Testing and microanalysis for the diagnostics and conservation of the Cultural and Environmental Heritage (02-06 June 2002, Antwerpen, Belgium). For more information consult http://chem-www.uia.ac.be/art2002/

- **ICC2002** - 15th International Corrosion Congress (22-27 September 2002, Granada, Spain). For more information consult http://www.15icc2002.com/intr.html

- Abbreviations and acronyms

AAD: Amsterdam Archaeological Department
AAS: Atom Adsorption Spectroscopy
AUSDC: Archaeological Unit of St Denis City
CT: Comuter-Tomography
DBU: Deutsche Bundesstiftung Umwelt
DNM: Danish National Museum
EDP: Erzbischöfliches Diözesanmuseum Paderborn
EDS: Energy Dispersive Spectroscopy
EVTEK: Espoo-Vantaa Teknillinen Ammattikorkeakoulu
FHA: Fachhochschule Aalen, ARGE Metallguss
FTIR: Fourier Transform Infrared
HEAA: Haute Ecole d´Arts Appliqués
ICN: the Netherlands Institute for Cultural Heritage
IRPA Institut royal du Patrimoine artistique
ITM: Institut für Technologie der Malerei

IRRAP: Institut de Restauration et de Recherches Archéologiques et Paléo-métallurgiques
KIK: Koninklijk Instituut voor het Kunstpatrimonium
LENS: Laboratorio Europeo di Spettroscopia non Lineare
LEPMI: Laboratoire d´Electrochimie et de Physicochimie des Matériaux et Interfaces de Grenoble
MIUW: Mineralogisches Institut der Universität Würzburg
MMF: Maritime museum of Finland
NMD: National Museum of Denmark
MRT: Mary Rose Trust
MSL: Museen der Stadt Landshut
NMF: National Museum of Finland
NPCS: National Photographic Conservation Studios
OPD: Opificio delle Pietre Dure
SABKS: Staatliche Akademie der Bildenden Künste Stuttgart
SEM: Scanning Electron Microscope
SM: State Museum
XRF: X-Ray Fluorescence
UPS: University of Paris Sorbonne
VCCW: Viborg County Conservation Workshop
VCM: Viborg County Museum
VUB: Vrije Universiteit Brussel

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