Editor:
Christian Degrigny
christian.degrigny@gmail.com
Assistant editor:
James Crawford
jamesbcrawford76@gmail.com

METALConsn-info

Metal working group

Bulletin of the Research On MEtal Conservation

July 2008

BROMEC 26

Editorial

For this issue we have several abstracts of talks presented during *METALEspana08* held in Madrid in April and co-organised by CSIC (Consejo Superior de Investigaciones Cientificas) and UAM (Universidad Autonoma de Madrid). This successful conference was certainly the first time that Spanish, Italian and French professionals working in metal conservation gathered and exchanged knowledge and ideas on current projects carried out in Spain. The programme of the conference is available on the conference website (http://www.cenim.csic.es/metalespana08/). The proceedings of the conference are in preparation and should be published in the next months.

The SPAMT Test research project presents the new developments of the "Ecorr-Drop Test" (EDT) monitoring technique as a "spot test" for the qualitative analysis of metals and more particularly copper-based alloys. It is carried out at La Chaux-de-Fonds (CH) conservation school. The second Swiss abstract of this issue is a final year diploma work from the same conservation school. The objective is to analyse and characterise the alloys constituting the oldest Swiss aircraft in order to construct a copy.

The presented Argentinian-Brazilian project relates to the well known problem of corrosion of outdoor bronze monuments in South American cities, while the Egyptian abstract shows the possibilities of galvanic coupling (with aluminium) to clean tarnished silver. The Australian managed *Cold climate conservation* project aims to study the response of standard metal treatments to cold climates. The project is only outlined but might interest countries having extreme winters.

This issue is the last one of the current editor. I would like here to thank all the people who contributed to the past 26 issues as well as James Crawford, assistant editor and Marie-Anne Loeper-Attia as well as Nathalie Richard who were in charge of the French translation of the issues.

As usual we hope that you will find this issue as useful and interesting as ever.

Editor
Christian DEGRIGNY
Assistant editor
James CRAWFORD

Contents

Page

Ongoing research project

 The PROMET project: development of innovative materials and techniques for the study and protection of metallic cultural heritage (***CENIM-CSIC / DPA – UAM***)

The PROMET project ("*Innovative Conservation Approaches for Monitoring and Protecting Ancient and Historic Metals Collections from the Mediterranean Basin*") was a research project funded by the 6th Framework Program of the European Union, with the participation of 21 partners from 11 different countries from the Mediterranean Basin (Egypt, France, Greece, Italy, Jordan, Malta, Morocco, Spain, Syrian Arab Republic and Turkey and also the Czech Republic), with the aim of developing new techniques and materials to improve the conservation of the metallic cultural heritage. The project has already been presented in BROMEC 12 and 16.

The joint work of researchers from the different countries has allowed the development of strategies for the evaluation of corrosion in metallic artefacts collections; the development and application of portable non-invasive (micro X-ray fluorescence, μ-XRF) or micro-destructive (laser induced breakdown spectroscopy, LIBS) analytical techniques; and the development and evaluation of corrosion inhibitors and coatings that fulfil the requirements of low toxicity, improved efficiency and durability and reversibility [1,2].

CENIM-CSIC and the UAM worked specifically on the evaluation of a new (in conservation-restoration) coating for protection against corrosion, Poligen ES91009 (a polyethylene wax emulsion manufactured by BASF), comparing it with traditional protection systems used in conservation-restoration: Paraloid B-72 and Renaissance Wax. The methodology developed within the PROMET project for the evaluation of the performance of those coatings when applied to historic metal objects combined electrochemical testing of artificially prepared coupons and testing on real objects. Electrochemical testing showed that Poligen is a very promising coating for conservation-restoration treatments of metallic artefacts: it surpassed the protection performance of traditional coatings. Results of the testing on real objects have also shown that its performance is very good on historic iron objects, but is not so good on archaeological iron or copper-based objects contaminated with chlorides.

1. Argyropoulos, V., Hein, A. and Abdel-Harith, M., International Conference on Strategies for Saving Indoor Metallic Collections with a Satellite Meeting on Legal Issues in the Conservation of Cultural Heritage, Cairo 25 February - 1 March 2007, TEI, 2007.
2. Argyropoulos, V. *Metals and Museums in the Mediterranean,* Protecting, Preserving and Interpreting,TEI, Athen, forthcoming.

Contacts: Emilio Cano, David M. Bastidas, Santiago Fajardo and José Maria Bastidas (CENIM-CSIC) and Joaquin Barrio, Jorge Chamon and Ana Isabel Pardo (DPA – UAM)
Funding: EU STREP INCO-MPC 1, 6th Framework programme

New research project

 Cold climate conservation (***ICS***)

The response of standard metal treatments to cold climates is an area that has been little researched. Taking advantage of the conservation work program being undertaken at Antarctica New Zealand's Scott Base on the artifacts of the historic huts of Scott and Shackleton, Sydney-based International Conservation Services (ICS) is developing a research program in this area. Working with a number of university and research bodies in Australia, New Zealand and Canada, ICS is planning an ongoing research program which will involve both monitoring the success of existing treatments and trialing new ones during the program, which is expected to run until at least 2012.

Contact: Julian Bickersteth (ICS)
Funding: -

New research project

Analysis and characterisation of alloys constituting the Dufaux 4 aircraft (***HEAA-Arc***)

This work carried out as a final year diploma of the High school of applied arts (conservation-restoration of scientific, technical and clockmaking objects) of La Chaux-de-Fonds, Switzerland is part of a large multidisciplinary project involving several students, apprentices and Swiss institutions.

Under the impetus of the Swiss aircraft association Helpta Aero, the project "The fake Dufaux" was setup to construct a copy of the oldest Swiss aircraft. The Dufaux 4 conserved in the Museum of Transport of Lucerne is dated from 1910. It was built and used by the brothers Henri and Armand Dufaux. It set the flying distance record some months after Louis Blériot by doubling his distance reached during his crossing of the English Channel. This aircraft is then an important piece of the Swiss technical heritage. A commemorative flight with the copy will take place at a date as close as possible to the 28th of August 2010, which corresponds to the 100th anniversary of the flying record.

The Dufaux 4 can be considered as the most representative production of the Swiss technical know-how in aircraft making at the beginning of the 20th century. This makes its study essential since it carries important technical information to conserve.

The objective of this project concerns the analysis and characterisation of the metals constituting the aircraft. More than 400 metal elements have been listed among which 20 representative samples have been examined metallographically in cross-section. Information obtained will be used to properly document the artefact, so to improve our knowledge on the aircraft and monitor any damage that might occur to the metallic elements. Furthermore similar metals will be considered for the construction of the copy.

Before examination, a thorough literature survey was performed on historic steel manufacturing techniques, especially in relation to the fabrication of specific elements. Our objective here was to support our understanding and interpretation of the analytical data. The collected historic data will then be compared with the analytical data.

Through this project we aim to further document the aircraft by precisely determining the alloys used, their manufacturing processes and, if possible, their dating.

Contact: Ludovic Rumo (HEAA-Arc)
Funding: no external funding

New research project



Patination nucleation on statuary bronze and brass ***(CIDEPINT / IQ-PUCV)***

This work focuses on the analysis of natural and artificial patina formation on statuary bronze and brass. Short-term natural ageing has been considered by exposing polished coupons to soft marine and urban atmospheres until first corrosion nucleus formation. The simplest laboratory patinas have also been made in an immersion-emersion CEBELCOR type equipment in distilled water during intermediate spans of time. Also the artificial degradation of the patinated metal coupons by SO_2 has been simulated in the same equipment using synthetic rainwater consisting on a 10^{-4} M $NaHSO_3$ solution as electrolyte. The structures formed during these different experimental conditions have been observed in an environmental scanning electron microscope coupled to an energy dispersive x-ray analyser. Electrochemical characterisation of artificially weathered bronze and brass allowed clarifying the role of alloying elements on initiation or the simplest patina formation processes as compared to pure copper as reference. They also contributed to a better understanding of the degradation of patina protectiveness observed in atmospheres containing the most aggressive anthropogenic pollutant. The outcomes of the project confirm the significant corrosion rate decrease observed from the latest atmospheric corrosion studies carried out in Europe that result from the great effort made in the last decades to control SO_2 emissions.

Contacts: Blanca Rosales (CIDEPINT), Jacqueline Hidalgo and Rosa Vera (IQ-PUCV)
Funding: no external funding

New research project

 Conservation approaches for monitoring and cleaning Ag and Ag-alloy artefacts ***(NRC-PCD)***

Accelerated tarnishing processes were developed based on both electrochemical and chemical protocols. High concentrations of sodium sulphide (0.1 M Na_2S) or anodic polarisation in low concentrations of Na_2S were used. A range of different colours (from yellow to dark) could be achieved within a few minutes and gloss level measurements were used to characterise the level of tarnishing (the lowest % corresponding to black tarnish). Open circuit potential versus time plots could also be used to monitor the tarnishing process where the potential shift to anodic direction shows the passivation of the metal surface.

Electrolytic cleaning was tested by applying cathodic current in a 10 % (1:1) sodium carbonate and sodium bicarbonate solution for certain periods of time (10-30 min.). It was compared to galvanic cleaning by coupling the tarnished metal with aluminium anode in the same solution. The tarnish layer was instantly removed in the latter case and the process could be followed through gloss level measurements. The present results indicate that the galvanic coupling with aluminium is one of the most appropriate methods for cleaning tarnished silver artefacts.

Contacts: Amin A. El-Meligi and Venice Gouda (NRC-PCD, Cairo, Egypt)
Funding: no external funding

New research project

SPAMT-Test: qualitative analysis of metallic elements on scientific, technical and clockmaking objects from E_{corr} versus time plots : feasibility and limits of use (***HEAA Arc***)

This project is a continuation of the work presented in BROMEC 11 and 15 where the objective was to study the possibilities of the "Ecorr-Drop Test" (EDT) monitoring technique as a "spot test" for the qualitative analysis of metals and more particularly copper-based alloys.

The technique is simple: the corrosion potential (E_{corr}) measured on a metal artefact, when a drop of solution (chosen to be non-aggressive/passive towards the material metal/patina) is deposited on its surface is monitored with time. During preliminary tests, we checked the reproducibility of the results on brass alloys tested with a sodium sesquicarbonate solution. Minor damage was observed on the metal surface, which passivated (passivation corresponds to the formation of a protective corrosion product) while higher concentrations of Zn in the alloy lowered the values of the corrosion potential. We extended this work to 16 certified copper based alloys kindly provided by the partners of the following EU projects: IMMACO and BRONZART and the INSTN (Institut National des Sciences et des Techniques Nucléaires). This time the electrochemical measurements were carried out with two solutions: 1% (w/v) sodium sesquicarbonate and "San Michel" brand Maltese mineralised water (chlorides: 71ppm, pH=6.8-7.3). A database giving the E_{corr} vs time plots for the 16 alloys was constructed but when testing it with unknown copper based objects we could observe that more data needed to be compiled to safely use this new "spot test".

The project SPAMT-Test was setup to pursue the work done on 50 reference copper-based alloys representative of scientific, technical and clockmaking objects. The multidisciplinary project is carried out by the Conservation Division of the High school of applied arts (HEAA Arc) in collaboration with the High school of Engineering so that the tool developed is not only both precise and affordable, but respects conservation ethics and requirements (least invasive as possible, portable). Because we want the tool to be used by conservators, the measurement protocol is designed by conservation professionals in contact with metal collections.

The project is divided in 3 steps. The protocol of measurements has been first defined with pure metals (Ag, Cu, Pb, Sn, Zn) and three (and not 2) test solutions: Swiss mineralised water (Henniez), 1% (w/v) sodium sesquicarbonate and 1% (w/v) KNO_3. We have just completed this work during which we standardised the measurement of E_{corr} by immersing the reference electrode (Ag-AgCl) in an extension filled with the testing solution so to prevent any pollution of the droplet of the test solution by the salts (chlorides) contained in the reference electrode. A syringe is used to form the droplet (constant volume). Metal coupons are handled with gloves after being polished thoroughly. All glassware is cleaned and rinsed properly before use. In parallel we completed the list of reference materials. Additional copper based alloys were kindly provided by CCI (Canadian Conservation Institute), ISC (Fraunhofer Institute for Silicate Research, D), CECM (Centre d'Etudes de Chimie Métallurgique, F), Swissmetal and private donations. Elements from real objects were also collected from the MIH (International Museum of Clockmaking, La Chaux-de-Fonds-CH) and the SAM (Swiss Army Museum, Thun). All materials were analysed with SEM-EDS and grouped in the following families: Cu-As, Cu-Sn, Cu-Sn-Ag, Cu-Sn-Pb, Cu-Zn, Cu-Zn-Sn, Cu-Zn-Pb, Cu-Zn-Ni, Cu-Zn-Sn-Pb, Cu-Ni and Cu-Al.

The next step is the construction of the database giving for the 50 reference materials their electrochemical behaviour in the three test solutions. The tool developed will then be applied on a group of real artefacts representative of scientific, technical and clockmaking collections so to qualitatively analyse the elements of these copper-based alloys.

Contact: Christian Degrigny (HEAA Arc)
Funding: HES SO

New research project

 Analytical study of lead cames from historic stained glass windows of different chronology and provenance (***IH-CCHS-CSIC / CENIM-CSIC / HAA-UA-CS***)

As is known, restoration of lead cames from stained glass windows usually involved re-melting of lead to form new profiles to be used again. However, many Medieval and Renaissance stained glass windows still conserve original lead cames. Such lead profiles frequently show better conservation states than others used during the 19th and 20th centuries as new materials for repositioning. This fact has been explained on the basis that more pure lead alloys have been used recently. These are more sensitive to corrosion than ancient ones that, probably, are well conserved due to the presence of some impurities.

With the aim to check this hypothesis, a sample set of 23 lead cames of different chronology (from 13-14th to 20th centuries) and different European provenance (Belgium, Netherlands, Spain and United Kingdom) has been studied. Lead profiles have been analysed by x-ray fluorescence (XRF) on the surface, once passivation and/or patination layers were removed. Likewise, cross-sections of samples were examined by field emission scanning electron microscopy (FESEM). Reference lead samples were also studied by conventional wet chemical analysis performed with atomic absorption spectrometry. The main impurities detected were tin, silver and antimony. In general, the results did not show a regular pattern between the chronology of samples and their content of impurities. Thus, the starting hypothesis was not confirmed.

Finally, other possible explanations to justify the different conservation states observed in the samples have been made. Particularly, the occurrence of recycling and repositioning of lead cames are considered as main factors affecting the present conservation state of samples. The negative influence of these two practices for accurate chronological determinations has to be taken into account as well.

Contacts: Manuel García-Heras (IH-CCHS-CSIC / CENIM-CSIC), I. Montero and M.A. Villegas (IH-CCHS-CSIC) and J.M.A. Caen (HAA-UA-CS)
Funding: no external funding

New research project

 Technical research on metallic threads from the vestments of a 19th c. statue: research on the production technology and state of conservation (***SDLM and DTR-VIRCCH***)

The restoration of the vestments of the *Virgen de los Desamparados* statue was the occasion to examine the metal threads associated with textile fabrics, determine their composition, establish their manufacturing technique and characterise their state of conservation at a microscopic level.

The oldest embroideries with metal threads in costumes of high value were made of high purity gold or silver. The Middle Ages saw the appearance of coated metals such as gilded silver, copper or brass, which substituted pure gold, while silvered copper replaced silver. The techniques of gilding and silver plating went through technological evolution with time. In some cases it is possible to relate the characteristics of the coating with the production technique used and thus refer to an accurate historic period.

The material characterization of metal threads was the first step of our conservation work and was used to define appropriate intervention strategies. Samples were observed by optical microscopy and analyzed by scanning electron microscopy with energy-dispersive x-ray microanalysis (SEM-EDS). The results are the following:

- metal sheets were produced with high purity silver with a thickness of 350-380 μm and a width of approximately 25-30 μm. The presence of longitudinal and parallel lines on the surface of the foils and the presence of rounded edges indicate that the manufacturing technique used to obtain the metal threads was the spinning process.
- gilding was applied on top. The thickness of the gold layer is 0,5-2 μm approximately. The microanalyses revealed a high percentage of gold that covers all four sides of the plated silver. The gilding process used was probably a chemical-electrochemical method or electrolytic bath.

The observation of the metal sheets revealed a loss of colour and brilliance; with dark grey appearance and the presence of various products from contamination (pollutant deposits) and alteration of silver (silver sulphide and chloride).

Other SEM-EDS investigations are in progress to identify exactly the technique used to deposit gold on silver. Comparative examination of similar metal threads of different historic pieces will be considered.

Contacts: Livio Ferrazza and, David Juanes (SDLM-VIRCCH) and, Mª Gertrudis Jaén Sánchez (DTR-VIRCCH)
Funding: no external funding

New research project

 Metal sculptures in the historic centre of Madrid: a review of their conservation and restoration ((***DPA-UAM / ACD***)

The preservation of urban metallic sculptures and monuments is a very specific issue. Their preservation problems are different from those of other metallic works (historic objects conserved indoor or archaeological remains). After the Industrial Revolution, cities have been quite unsuitable places to keep these sculptures and monuments in good states of conservation, due to poor environmental conditions. Therefore, during the last two centuries and especially since the last half of the 20th century, cleaning and adjustment works were regularly performed on these metallic objects.

The transformations of Madrid, the increasing pollution and the traumatic political events that happened in Spain from the last half of the 19th century to the 1940's had a strong impact on the statues exposed outdoor. Their location, on quite strategic and symbolic places of the city, have determined their preservation chances and also corresponded with their present conservation state.

Within this work three bronze sculptures of a huge importance, not only for the city of Madrid, but also to the country of Spain have been studied. We are referring to the equestrian statues of Philip III, located at Plaza Mayor, and Philip IV, placed at Plaza de Oriente, and the two lions on the podium of the façade of the Palacio del Congreso de los Diputados, at Carrera de S. Jerónimo. The two equestrian statues are undoubtedly two of the best equestrian representations of European sculpture. Historic records on these monuments are sometimes missing but the history of their preservation and restoration can, to a greater or lesser extent, be reconstructed. Naturally this history is studied within the framework of the ethics and the conservation techniques applied to urban metallic artworks that are rather different from those employed to archaeological or museum objects.

This work is an initial contribution to a history of conservation and restoration of the cultural and historic heritage in Spain. Such work has a growing importance since it is our duty to preserve this rich legacy and pass it down to the next generations.

Contacts: Joaquín Barrio Martín (DPA-UAM) and Montserrat García Muño(ACD)
Funding: no external funding

New research project

 Functional character and restoration criteria: comparative research of cleaning on a liturgical cross (Vado-Cervera, Palencia, Spain) (***CCRBC***)

The restoration of works in silver prioritizes the recovery of the function over another aspect connected with the material reality of the liturgical object. Therefore interventions have generally remained in the hands of jewellers, imposing a recovery criterion: to put in service again that which was broken and to restore its prior appearance. In the case of the cross of Vado-Cervera (Palencia, Spain) - a disused liturgical object, we could apply criteria based on the preservation of the object and its historic interventions.

The materials employed (gilded copper with small insertions of enamel) were made by means of diverse techniques: stamped, beaten and chiselled, with the inclusion of small figures in gilded bronze obtained by moulding and smelting processes. The evaluation of the production techniques, along with the analytical study by PIXE (Particle Induced X-ray Emission) and RBS (Rutherford Backscattering Spectrometry) confirmed the mass production of such a type of object, with artisans specialized in the manufacture of the diverse elements.

The cleaning protocol started with comparative tests using laser cleaning with a NdYAG 1064, 6ns versus chemical cleaning with H_3PO_4 (10% vol/vol) + H_2O_2 (5 vol) + tensioactive solution + methylcellulose). As regards the laser cleaning, the RBS showed that a structural modification was produced in the gold layer. This effect was not observed with the chemical procedure. Therefore this chemical procedure was considered safer so to conserve the detailed knowledge of the stratigraphic morphology of the gilded surface.

Contact: Cristina Escudero (CCRBC)
Funding: -

General information

Websites

- **ARTECH network**: http://server.icvbc.cnr.it/progetti_futuri/progetto_artech.htm. Network facilitating the access of conservation professionals to different investigation techniques of Cultural Heritage artefacts

- **BIGSTUFF (Care of Large Technology Objects) 2004:**
http://www.awm.gov.au/events/conference/bigstuff/index.asp

- **CAMEO**: website containing chemical, physical, visual, and analytical information on over 10,000 historic and contemporary materials used in the conservation, preservation, and production of artistic, architectural, and archaeological materials
http://www.mfa.org/_cameo/frontend/

- **Cost Action G8: Non-destructive analysis and testing of museum objects.** http://srs.dl.ac.uk/arch/cost-g8. Abstracts and booklets from previous workshops can be downloaded as well as announcements of past activities (Short Term Scientific Missions deadlines, training schools…).

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

- **Cost Action D42: ENVIART** (Chemical Interactions between Cultural Artefacts and Indoor Environment): www.enviart.org. You have to register (free access) to get access to all information.

- **e-Preservation Science**: http://www.e-preservationscience.org. Online publication of papers in conservation science.

- **European Cultural Heritage Network**: http://www.echn.net/. European network of professionals interested in the conservation of Cultural Heritage.

- **ICOMAM**: International Committee of Museums and Collections of Arms and Military History: http://www.klm-mra.be/icomam

- **Industrialartifacts review** (http://industrialartifactsreview.com/): the site put great emphasis on industrial design and the role of art and photography in promoting cultural heritage.

- **IR and Raman for cultural heritage:** http://www.irug.org/default.asp

- **LabS-TECH network** http://www.chm.unipg.it/chimgen/LabS-TECH.html

- **Laboratoire Pierre Sue**: LPS PhD thesis related to the alteration of archaeological artefacts can be downloaded from http://www-drecam.cea.fr/lps/ (in French) and go to "Archéomateriaux et prévision de l'altération."

- **METAL*Consn*-info** homepage: http://rsc.anu.edu.au/~hallam/METALConsn-info.html

- **M2ADL** - Microchemistry and Microscopy Art Diagnostic Laboratory is now available at the following website: http://www.tecore.unibo.it/html/Lab_Microscopia/M2ADL/

- **New York Conservation Foundation** website: http://www.nycf.org/

- **PROMET** website: http://www.promet.org.gr

- **RESTAURACION METAL SUR AMERICA**: www.restauraciondemetales.cl

- **TEL (PhDs on line):** http://tel.ccsd.cnrs.fr/

- **Working Group Metals ICOM -Committee for Conservation**
http://icom-cc.icom.museum/WG/Metals/

- **Online publications of Surface Engineering Journal.** Issue addressing specifically to Metal issues: **Surface Modification Issues in Art**, Volume 17, Issue 3, June 2001. Can be downloaded
from:(http://www.ingentaconnect.com/content/maney/se/2001/00000017/00000003;jsessionid=1xpmlw91522a3.victoria)

- **ANDRA** (Agence Nationale pour la Gestion des Déchets RadioActifs)
http://www.andra.fr/interne.php3?publi=publication&id_rubrique=82&p=produit&id=5. The following documents can be ordered for free from this website : *Analogues archéologiques et corrosion* (in French only) and *Prediction of Long Term Corrosion Behaviour in Nuclear Waste Systems* (in English).

Future seminars and conference

- **9th Nordic conference on the application of scientific methods in archaeology** (11-14 September 2008, Trondheim, NO), hosted by the Section of Archaeology and Cultural History at the Museum of Natural History and Archaeology, Norwegian University of Science and Technology (NTNU), in Trondheim, Norway. For more information visit the conference site http://www.vm.ntnu.no/vm/smia
- **The 8th European Conference on Research for Protection, Conservation and Enhancement of Cultural Heritage** (11-13 November 2008, Ljubljana, Slovenia) organised by the National and University Library of Slovenia. For more information visit the conference site www.chresp.eu
- **CSA 2008: mobile analytics for heritage conservation** (17-18 November 2008, Somerset, USA) organised by John Scott (NYCF) and David Thickett (English Heritage). For more information visit the following website: http://www.eas.org/pdf/Update.pdf (search on heritage and preservation)
- Workshop **AURUM**, authentication and analysis of gold work (11-13 May 2009, Paris, F) organised by the Centre for Research and Restoration of French Museums (C2RMF) and supported by the 6th Framework Programme of the European Commission. For more information please contact Dr Guerra (maria.guerra@culture.gouv.fr)
- the **17th International Bronze Congress** (24-28 May 2009, Athens, Gr) will be sponsored and organised by the American School of Classical Studies at Athens, the Center for the Ancient Mediterranean of Columbia University, and the University of Athens. For more information please contact Alessandra Giumlia-Mair (giumlia@yahoo.it).

Abbreviations and acronyms

ACD: Archivo del Congreso de los Diputados, Madrid
CCRBC: Centro de Conservación y Restauración de Bienes Culturales. Valladolid, Spain
CENIM-CSIC : Centro Nacional de Investigaciones Metalúrgicas, Madrid, Spain
DPA – UAM : Depto de Prehistoria y Arqueologia, Universidad Autonoma de Madrid
DTR-VIRCCH: Departament Textile Restoration. Valencian Institute of Restoration and Conservation of Cultural Heritage
HA-UA-CS : Hogeschool Antwerpen Assoc., University of Antwerpen, Conservation Studies, Antwerpen, Belgium
HEAA Arc: Haute Ecole d'Arts Appliqués Arc
HES SO: Haute Ecole Spécialisée de Suisse Orientale
ICS: International Conservation Services, Sydney
IH-CCHS-CSIC: Instituto de Historia. Centro de Ciencias Humanas y Sociales, Madrid, Spain
IQ-PUCV: Instituto de Quimica, Pontificia Universidad Catolica de Valparaiso, Chile
NRC-PCD: National research centre, Physical Chemistry Department, Cairo, Egypt
SDLM-VIRCCH : Scientific Department, Laboratory Materials. Valencian Institute of Restoration and Conservation of Cultural Heritage
SEM : Scanning Electron Microscope

.

Contacts

Joaquin Barrio / DPA – UAM (joaquin.barrio@uam.es)
Julian Bickersteth / ICS (j.bickersteth@icssydney.com)
Emilio Cano / CENIM-CSIC (ecano@cenim.csic.es)
Amin A. El Meligi / NRC-PCD (ael_meligi10@hotmail.com)
Cristina Escudero / CCRBC (escremcr@jcyl.es)
Livio Ferrazza / SDLM-VIRCCH (livio_ferrazza@yahoo.it)
Manuel García-Heras / IH-CCHS-CSIC / CENIM-CSIC (mgheras@ih.csic.es)
Gertrudis Jaén Sánchez / DTR-VIRCCH (majaesan@hotmail.com)
David Juanes / SDLM-VIRCCH (david.juanes@uv.es)
Blanca Rosales / CIDEPINT (brosales@fibertel.com.ar)
Ludovic Rumo / HEAA Arc (ludovic.rumo@he-arc.ch)

National contact persons for the homepage **METAL*Consn*-info**

Argentina: Blanca Rosales, researcher, CIDEPINT, La Plata
Australia: David Hallam, senior conservator of objects at the National Museum of Australia, Canberra
Belgium: Annemie Adriaens, researcher and lecturer, head of the group "Electrochemistry and Surface Analysis", Ghent University, Ghent and Gilberte Dewanckel, conservator at IRPA (Institut Royal du patrimoine artistique), Bruxelles
Bulgaria: Petia Penkova, conservator, National Academy of Arts, Department of conservation-restoration, Sofia
Canada: Judy Logan, conservator (retired), Ottawa
Chile: Johanna Theile, conservator and lecturer, Facultad de Arte - Universidad de Chile Las Encinas, Santiago de Chile
Croatia: Goran Budija, conservator, Museum of Arts and Crafts, Zagreb
Czech Republic: Dusan Perlik, conservator, Museum of Central Bohemia, Roztoky
Denmark: Karen Stemann Petersen, conservator, The National Museum of Denmark, Copenhagen
Egypt : Wafaa Anwar Mohamed, conservator, Giza

Finland : Eero Ehanti, conservator, Maritime Museum of Finland, Helsinki
France: Marie-Anne Loeper-Attia, conservator and assistant-lecturer at the Conservation Department, Institut National du Patrimoine, St Denis, Paris and Christian Degrigny, conservation scientist, Château de Germolles, Germolles
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
Hungary: Balazs Lencz, senior conservator, Conservation Department, Hungarian National Museum, Budapest
Italy: Paola Letardi, scientist, Istituto per la corrosione marina dei metalli (ICMM), Genova
The Netherlands: Ineke Joosten, conservation scientist, The Netherlands Institute of Cultural Heritage, Amsterdam
Morocco: Hind Hammouch, scientist, Laboratory of Electrochemistry, Corrosion and Environment, Faculty of Science, Université Ibn Tofail, Kenitra
Norway: Douwtje Van der Meulen, conservator, Conservation Department, University of Oslo, Oslo
Portugal: Isabel Tissot, conservator, Portuguese conservation-restoration Institute, Lisbon
Romania: Dorin Barbu, conservator, Brukenthal Museum, Sibiu
Russian Federation: Andrey Chulin, conservator, the State Hermitage Museum, St Petersburg
South Africa: Jaco Boshoff, maritime archaeologist, Iziko Museums of Cape Town, South Africa
Spain: Emilio Cano, conservator, National Centre for Metallurgical Research (CENIM), Spanish Council for Scientific Research (CSIC), Madrid
Sweden: Helena Strandberg, conservator and conservation scientist, freelancer, Göteborg
Switzerland: Valentin Boissonnas, conservator and lecturer, Haute école d'arts appliqués Arc, La Chaux-de-Fonds
United Kingdom: Catia Viegas Wesolowska, conservator, Victoria & Albert Museum, Londres & Mark Dowsett, physicist, Warwick University, Coventry
USA: John Scott, New York Conservation Foundation, New York