

# BROMECC 32

## Bulletin of Research on Metal Conservation

March 2011

### Editorial

BROMECC 32 largely presents post-graduate research – an essential conservation research sector that not only provides essential training for conservators and conservation scientists, but one that makes a significant contribution to the breadth of research in our field as a whole. Post-graduate metals conservation research is supported by BROMECC via its international promotion, and encourages supervisors and their students to put forward their best work into this international arena. Four *new research projects* and one *ongoing project* are reported in this issue. Of the *new research projects*, treatment options are being investigated for waterlogged Baroque metal-organic composite coffins excavated from an urban site in Berlin as part of a master's training in conservation and restoration. From north-western Italy, a PhD project surveying outdoor metallic artworks for their composition, degradation and conservation methods is given. Also outlined is a bilateral agreement of scientific cooperation between Italy and Morocco that uses plant extracts to develop non-toxic corrosion inhibitors for copper alloys. Meanwhile, anthropologists and an electron microscopist describe their efforts to investigate trace amounts of remnant ore found on the surfaces of metal ore millstones in southern France. Lastly, the update on the *ongoing project* is made by a PhD student who reveals the corrosion products detected while using a diffraction technique on a wrought iron surface as it reacts in simulated conservation treatment solutions over time.

New information for *future seminars and conferences* includes the meetings: "Preserving Archaeological Remains in situ (PARIS4)"; "6th International Congress on the Application of Raman Spectroscopy in Art and Archaeology"; "IV Latin-american Congress on Metal Conservation and Restoration 2011"; and "History, Technology and Conservation of Ancient Metal, Glasses and Enamels". An *announcement* for a new reference text on metallography is made, while new *websites* are listed for the "European Federation of Corrosion's Working Party 21" (corrosion of archaeological materials) and for accessing the extended abstracts from the "Archaeological Iron Conservation Colloquium 2010".

According to surveyed participants, the ICOM-CC Metal 2010 meeting in Charleston, USA was a successful and recommended meeting. It provided an engaging balance between presentation time and question time – often resulting in an unremitting queue of enquiring audience members! These questions and answers were recorded for inclusion in the final conference publication. The ballot for the next ICOM-CC Metal meeting was recently cast online by members and the venue for 2013 has been announced as Edinburgh.

In news from the National Contact Persons, Judy Logan of Canada has decided to vacate her role. Many thanks to Judy for her contributions! Persons interested in carrying out the dynamic and engaging role of a National Contact Person in countries with vacancies are invited to contact the ICOM-CC Metals Working Group Co-ordinator, David Hallam ([d.hallam@nma.gov.au](mailto:d.hallam@nma.gov.au)), who can provide you with further information on the recently revised expectations of these engaging roles.

Lastly, the new, abstract image behind the title header of this issue has been provided for the first time by one of our authors, Beck et al. Its intention is to provide a readily identifiable appearance for each issue. Thanks to co-ordination by Diana Lafuente we will continue to publish images from submissions this way.

Enjoyable reading!

James Crawford

#### Anglophone Editor & Translator:

James Crawford  
[jamesbcrawford76@gmail.com](mailto:jamesbcrawford76@gmail.com)

#### Francophone Coeditor:

Michel Bouchard  
[mbouchard@caraa.fr](mailto:mbouchard@caraa.fr)

#### Francophone Translators:

Nathalie Richard  
[n.richard.elmesti@videotron.ca](mailto:n.richard.elmesti@videotron.ca)

Elodie Guilminot  
[elodie.guilminot@arcantique.org](mailto:elodie.guilminot@arcantique.org)

Marc Voisot  
[horloqer@pendulerie.com](mailto:horloqer@pendulerie.com)

#### Hispanophone Coeditor:

Emilio Cano  
[ecano@cenim.csic.es](mailto:ecano@cenim.csic.es)





#### Hispanophone Translators:

Diana Lafuente  
[diana.lafuente@gmail.com](mailto:diana.lafuente@gmail.com)


Inmaculada Traver  
[lacirujanadelarte@gmail.com](mailto:lacirujanadelarte@gmail.com)

## Contents

### New research projects

	<i>Six different materials one conservation treatment: the inhibition of metal corrosion in polyethylene glycol baths</i> .....	3
	<i>Study and conservation of outdoor metallic artworks belonging to Ligurian Cultural Heritage</i> .....	4
	<i>Development of new non-toxic corrosion inhibitors for protecting copper-based archaeological artefacts</i> .....	5
	<i>Ore provenance of past iron industry: detection and conservation of metallic traces</i> .....	6

### Ongoing research projects

	<i>In situ monitoring of dechlorination treatments of marine archaeological artefacts by micro X-ray diffraction</i> .....	7
	Abbreviations and acronyms .....	8

### General information

Future seminars and conferences .....	9
Announcements.....	10
Websites .....	10
National Contacts .....	13

**Cover image:** “Detail of top view of coffin 372 after recovery of the block”, credit: Marianne Landvoigt and Brit Göring. Refer to abstract by Beck et al., “Six different materials one conservation treatment: the inhibition of metal corrosion in polyethylene glycol baths”.

**BROME C website:** <http://www2.warwick.ac.uk/fac/sci/physics/research/condensedmatt/sims/bromec/>

**BROME C subscription:** <http://listserv.csv.warwick.ac.uk/mailman/listinfo/bromec-bulletin-of-research-on-metal-conservation>

## Six different materials one conservation treatment: the inhibition of metal corrosion in polyethylene glycol baths (HTW)<sup>1</sup>

### New research project



**Contact:** Sabine Beck  
[Sabine.Beck@student.htw-berlin.de](mailto:Sabine.Beck@student.htw-berlin.de) (HTW), Ilona  
 Hinneburg ([ap47ih@web.de](mailto:ap47ih@web.de))  
 (HTW)

**Funding:** Landesdenkmalamt  
 Berlin, European fund for  
 regional development,  
 University of Applied Sciences –  
 HTW Berlin

A masters project at the University of Applied Sciences - HTW Berlin, deals with three Baroque children's coffins excavated from the Berlin city centre in spring 2008<sup>2</sup>. The project is supported by the Museum für Vor- und Frühgeschichte, Staatliche Museen zu Berlin, Landesdenkmalamt Berlin and the European fund for regional development, which supports the IMPACT program of the university.

The composite object consists of six different materials. The basic material is wet oak wood spanned with goat leather that had first been stretched on two layers of textile to maintain its shape. The functional elements are of iron and a lead-copper alloy. The children's names, birthdays and dates of death had been pressed into the surface with brass nails featuring gilded surfaces.

The aim of the conservation treatment is to find a stabilisation method sympathetic to all the organic and inorganic parts of this composite object. For the conservation of the organic materials, a polyethylene glycol (PEG) treatment of different molecular weights is necessary. Therefore, different concentrations of PEG 400 and PEG 4000 are being examined. However, publications often highlight the acidic character of PEG as one of the reasons for its corrosivity. To better understand the environment in the PEG-treatment the pH-values are being measured. There are different methods that might protect against the corrosivity of PEG-baths, e.g. corrosion inhibitors, salts, buffers, oxidants and metal anodes. Corrosion inhibitors, buffers and oxidants are difficult to deal with in the case of the children's coffins. Each of these methods might lead to safely conserved metal components, but they might also react in an unpredictable way with the organic materials, or the PEG. Thus, the main efforts to protect the metals from corrosion are being investigated using different salts and metal anodes. Varying preliminary tests with different PEG concentrations, different salts and anodes with recent and archaeological materials are being carried out.

1. Original language version; submitted by author in English.

2. [http://krg.htw-berlin.de/aktuelle\\_projekte/64.html](http://krg.htw-berlin.de/aktuelle_projekte/64.html);  
[http://aahh-bernds-berlin.npage.eu/ausgrabungen\\_schlossplatz\\_berlin\\_49691720.html](http://aahh-bernds-berlin.npage.eu/ausgrabungen_schlossplatz_berlin_49691720.html);  
<http://www.youtube.com/watch?v=Sqp5t4TZSIM>; <http://impact.htw-berlin.de/index.php>

## Study and conservation of outdoor metallic artworks belonging to Ligurian Cultural Heritage (*DCCI-DIRAS, USG, UZ, UV*)<sup>1</sup>

### New research project



**Contact:** Valeria Bongiorno (DCCI, USG) ([valeria.bongiorno@gmail.com](mailto:valeria.bongiorno@gmail.com)), Paolo Piccardo (DCCI, USG), Franco Sborgi (DIRAS, USG), Marilena Carnasciali (DCCI, USG)

**Funding:** PhD grant from Regione Liguria

The research aims are the conservation and improvement of metal artefacts (mainly statues) belonging to Ligurian Cultural Heritage. The activities planned to reach these goals are the:

- characterization of the constitutive materials and of the corrosion layers of selected artworks;
- establishment of a database of the alloys used and the corrosion products found;
- study and comprehension of the deterioration mechanisms of metallic works of art;
- study and comprehension of the protectiveness of artificial patinas (i.e. artistic and aesthetic patinas made at the foundry);
- evaluation of laser cleaning treatment (efficiency of corrosion product removal and advantages and disadvantages on the interaction with the metal substrate); and
- evaluation of the protective treatments traditionally applied in the field of restoration of metal objects.

During the first stage of the research the constitutive materials and the composition of the corrosion layers of three metal sculptures belonging to the Monumental Cemetery of Staglieno (Genoa, Italy) were characterized through the application of some analytical techniques (SEM-EDXS, Raman spectroscopy)<sup>2</sup>. The alloys of the sculptures (three quaternary bronzes of different compositions) were reproduced and subsequently characterized to confirm their nature. From each ingot twenty-five samples (1.5 x 2.0 x 0.4 cm) were cut and then patinated using different methods (immersion, paste application and torch technique) and recipes<sup>3, 4, 5, 6</sup>. These patinas were then characterized with EDXS microanalysis and Raman microspectroscopy. To study the corrosion mechanism of the alloy and the protectiveness of the produced patinas, the samples will be subjected to ageing in salt spray chambers (with step by step EIS measurements) and to potentiodynamic tests for corrosion resistance. The aged samples, after characterization with OM, SEM-EDXS, micro-Raman and XRD analyses, will be used to test the efficiency of cleaning treatments with pulsed laser (this work will be performed in cooperation with the University of Zaragoza and the University of Vigo, Spain) and with mechanical methods (e.g. air abrasive blasting).

1. Original language version; submitted by author in English.

2. V. Bongiorno, P. Piccardo, F. Sborgi, *Diagnostics on metallic monuments and decorative objects of the Monumental Cemetery of Staglieno, Proceedings of the 33<sup>rd</sup> AIM National Meeting (2010), Brescia (I), Nov. 2010.*

3. A.H. Hiorns, *Metal colouring and bronzing (1892) 95-256*

4. W.J. Kaup, E.F. Lake, *Metal colouring and finishing – Methods of producing colours on iron, steel, copper, bronze, brass and aluminium – Burnishing metals (1914) 3-26*

5. R. Hughes, M. Rowe, *The colouring, bronzing and patination of metals (1991) 9-164*

6. M. Ruhland, *Antiquing of brass, copper, and bronze, Metal finishing 98(1) (2000) 458-464*

## Development of new non-toxic corrosion inhibitors for protecting copper-based archaeological artefacts (ISMN-CNR, LECE-FSK)<sup>1</sup>

### New research project



**Contact:** Maria Pia Casaleto  
([mariapia.casaleto@ismn.cnr.it](mailto:mariapia.casaleto@ismn.cnr.it)) (ISMN-CNR), Prof.  
Najat Hajjaji (LECE-FKS).

**Funding:** International Bilateral  
Agreement of Scientific and  
Technological Cooperation  
CNR/CNRST Morocco  
2010/2011

A growing need of Mediterranean conservation institutions and museums is to develop and use alternative safe and reliable long-term conservation methods and strategies for bronze archaeological artefacts that could replace the presently-used hazardous materials and processes. Conservation materials and processes should be used following standardized, reliable and reproducible procedures for removing soil traces, for stabilising bronze archaeological artefacts and for avoiding further degradation during exhibition or storage. Degradation phenomena occurring during archaeological burial, post-excavation and exhibition or storage are the major problems encountered for Cu-based artefacts. *Bronze disease* is the most dangerous form of archaeological bronze degradation due to a cyclic reaction that involves copper from the alloy and chlorides as a corrosive agent. A conventional method to cure bronze disease requires protection with a 3-6 wt.% benzotriazole (BTA) alcoholic solution at T = 60 °C, but unfortunately BTA is toxic and a suspected carcinogen. The development of new and safe protection systems should offer alternative choices to conservation-restoration professionals for effective products to stabilize and protect metal artefacts. These should be safe to use and dispose.

In this context, this research project deals with the investigation of the corrosion inhibition properties of different artificially synthesized and naturally produced compounds. In order to focus primarily on safety and health concerns, plant extracts will be tested as corrosion barriers and/or inhibitors. The main advantages of these products lie in their ease of use, low cost and safe properties for both humans and the environment. The main application of corrosion inhibitors in conservation is in the form of coatings or *dry films*, i.e. forming an inhibitor layer chemically bonded to the surface of the metal. Since archaeological artefacts are unique and not easily available objects, reference materials are required to evaluate the anti-corrosion properties of innovative compounds towards bronze disease. In this research project, modern reference Cu-based alloys, intentionally produced by ISMN-CNR with a chemical composition and micro-chemical structure similar to that of ancient alloys, will be used as substrates. The efficiency of the inhibitors will be investigated by using electrochemical techniques (voltammetry and electrochemical impedance spectroscopy (EIS)). Substrates and films will be characterized by using different surface and bulk analysis techniques, such as optical microscopy (OM), scanning electron microscopy coupled with energy dispersive X-ray spectroscopy micro-analysis (SEM-EDS), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy and X-ray diffraction (XRD).

<sup>1</sup>. Original language version; submitted by author in English.

## Ore provenance of past iron industry: detection and conservation of metallic traces (IPH, UP) <sup>1</sup>

### New research project



**Contact:** Pierre-François Puech ([pfpuech@yahoo.fr](mailto:pfpuech@yahoo.fr)) (IPH), Bernard Puech (IPH), Roger Notonier (UP)

**Funding:** No external funding

The purpose of this research is to determine the cycle of the archaeological items provenancing iron-rich areas that correspond to pre-20th century ironwork forges. Data from La Barthe, close to Ambialet, Tarn (France), were collected in order to create a record of this mining district.

Forges in the area arose close to iron mines, where charcoal (forests) and hydropower were also present. Many of these small forges, which only worked part time and for a short period, have left few traces. Our investigation method is related to the identification of the surface traces with their conservation and laboratory analysis in mind.

Currently, little data are available on the workshops that accompanied the various inventoried pits that were bored in the countryside for extracting the iron ore. Our work led to the discovery of rotating grinding millstones. The type of these millstones, their raw materials, their fabrication and evidence of use inform on the urban populations of the Ségalas and allow understanding the cultural unity of that group over several centuries.

For the identification and conservation of the deposits on the dynamic surface of the grinding wheels we used surface impressions. The technique is similar to nitro-cellulose varnish replicas that allow the use of various analytical microscopy techniques. SEM observation allows detecting and keeping track of the metallic elements present in trace amounts.

1. Translated by M. Bouchard and J. Crawford. Original version submitted by author in French; refer to BROME C 32 French version.

## *In situ* monitoring of dechlorination treatments of marine archaeological artefacts by micro X-ray diffraction (CEA, AA, SS, LEMMA)<sup>1</sup>

### Ongoing research project



**Contact:** Florian Kergourlay ([florian.kergourlay@cea.fr](mailto:florian.kergourlay@cea.fr)) (CEA), Delphine Neff (CEA), Solenn Reguer (CEA), Philippe Dillmann (CEA)

**Funding:** BDI, CNRS, Synchrotron SOLEIL

Restoration-conservation workshops currently use treatments based on the extraction of chloride ions to avoid the drastic alteration that underwater ferrous archaeological artefacts can undergo after their excavation. Indeed, the chloride ions trapped within the corrosion products of underwater ferrous artefacts accelerate the corrosion processes in aerated and moist media. Although these dechlorination treatments experience success, they remain under-optimized (duration of treatment, lack of reproducibility...).

In the framework of a PhD and in close collaboration with a specialised restoration-conservation laboratory, Arc'Antique, and the Laboratoire d'Etudes des Matériaux en Milieux Agressifs (LEMMA UMR 6250 CNRS/Univ. La Rochelle), the Laboratoire d'Archéomatériaux et Prévision de l'Altération à long terme (SIS2M/LAPA UMR 3299 CNRS/CEA) and the DiffAbs beamline at the SOLEIL synchrotron, we investigate the dechlorination mechanisms involved in the stabilization treatments applied to artefacts from marine archaeological sites (refer to BROME C 29). For this purpose, a set of samples composed of Roman wrought iron ingots dated from 50AD and coming from Gallo-Roman shipwrecks of Les Saintes-Maries-de-la-Mer (France) has been studied.

Thanks to a dedicated cell, *in situ* structural investigation of the corrosion pattern's evolution during aerated and deaerated chemical treatments has been performed by  $\mu$ XRD imaging. A fine description of the corrosion pattern during a 24-hour treatment has been achieved. Three areas can be highlighted:

- i. a non-treated area composed of the initial corrosion product ferrous hydroxychloride ( $\beta$ -Fe<sub>2</sub>(OH)<sub>3</sub>Cl)
- ii. a transition area made of a mix of  $\beta$ -Fe<sub>2</sub>(OH)<sub>3</sub>Cl, ferrous hydroxide (Fe(OH)<sub>2</sub>) and magnetite (Fe<sub>3</sub>O<sub>4</sub>); and
- iii. a treated area where  $\beta$ -Fe<sub>2</sub>(OH)<sub>3</sub>Cl has entirely evolved into Fe(OH)<sub>2</sub> and Fe<sub>3</sub>O<sub>4</sub>.

Dechlorination rates can be assumed from the observation of the transformation of the corrosion products within the layer. These results allow a more thorough comprehension of dechlorination mechanisms involved during a treatment. The next step is to clearly understand what effect the different stages (treatment, washing and drying) have on the transformation of the object.

<sup>1</sup>. Original language version; submitted by author in English.

## Abbreviations and acronyms

AA: Arc'Antique, France

BDI: bourse de doctorat pour ingénieur

BTA: benzotriazole

CEA: Commissariat à l'énergie atomique, France

CNRS: Centre national de la recherche scientifique, France

DCCI: Dipartimento di Chimica e Chimica Industriale, Italy

DIRAS: Dipartimento di Italianistica Romanistica Arti e Spettacolo, Italy

EDS/EDXS: energy dispersive X-ray spectroscopy

EIS: electrochemical impedance spectroscopy

HTW: University of Applied Sciences – Hochschule für Technik und Wirtschaft HTW Berlin, Germany

IPH: Institut de Paléontologie Humaine, France

ISMN-CNR: National Research Council of Italy, Italy

LECE-FSK: Université Ibn Tofail, Morocco

LEMMA: Laboratoire d'Etudes des Matériaux en Milieux Agressifs, France

OM: optical microscopy

PEG: polyethylene glycol

SEM: scanning electron microscopy

SS: Synchrotron SOLEIL, France

UP: Université de Provence, France

USG: Università degli Studi di Genova, Italy

XPS: X-ray photoelectron spectroscopy

XRD: X-ray diffraction



## General information

### Future seminars and conferences

- **New** **Preserving Archaeological Remains in situ (PARIS4)** (23-26 May 2011, Copenhagen, Denmark). The fourth PARIS conference will be held at the National Museum of Denmark. Over 50 abstracts for oral and poster presentation have been received covering the themes: degradation of archaeological remains; monitoring and mitigation case studies; protocols, standards and legislation for monitoring and management; preserving archaeological remains in situ. For further information and registration please visit [www.natmus.dk/paris4](http://www.natmus.dk/paris4).
- **New** **6<sup>th</sup> International Congress on the Application of Raman Spectroscopy in Art and Archaeology (RAA 2011)** (5-8 September 2011, Parma, Italy). The conference welcomes all contributions on the application of Raman Spectroscopy in the fields of art history, history, archaeology, palaeontology, conservation and restoration, degradation of cultural heritage, archaeometry. Call for abstracts: before 1 March, 2011. Publication: on the occasion of RAA2011 conference, a special issue of the Journal of Raman Spectroscopy will be published. [www.fis.unipr.it/raa2011/](http://www.fis.unipr.it/raa2011/) [RAA2011@fis.unipr.it](mailto:RAA2011@fis.unipr.it)
- **New** **IV Latin-american Congress on Metal Conservation and Restoration 2011** (*Congreso Latinoamericano de Conservación y Restauración de Metal*) (13-17 September 2011). It will be held at the Instituto del Patrimonio Cultural de España (IPCE-Ministerio de Cultura) in Madrid. Deadline for abstracts submissions: April 29. Contact: [congresos.ipce@mcu.es](mailto:congresos.ipce@mcu.es) <http://www.mcu.es/patrimonio/MC/CLCRM/index.html>
- **New** **History, Technology and Conservation of Ancient Metal, Glasses and Enamels** (16-19 November 2011, Athens, Greece). An international symposium organized by N.C.S.R. "Demokritos"/Institute of Materials Science and The National Technical University of Athens (NTUA)/Department of Chemical Engineering. A meeting for researchers, scientists, archaeologists, conservation scientists and executives who are involved in the history, technology and conservation of ancient materials in Greece and adjacent areas. The official language will be English. Oral/poster abstract submission deadline: 20 June 2011. Early registration deadline: 30 September 2011. Contact: [lfilip@ims.demokritos.gr](mailto:lfilip@ims.demokritos.gr)
- **3<sup>rd</sup> International Conference, Archaeometallurgy in Europe 2011** (29 June-1 July 2011, Bochum, Germany). The call for presenters and attendees is open for this interdisciplinary conference hosted by the Deutsches Bergbau-Museum ([www.bergbaumuseum.de](http://www.bergbaumuseum.de)). For more information contact Andreas Hauptmann: [aie3@bergbaumuseum.de](mailto:aie3@bergbaumuseum.de)

## Announcements

- **New** **Publication: Ancient Metals: Microstructure and Metallurgy Volume I.** (David A. Scott 2010). Metallography is the scientific examination of metals using the optical microscope to study grains, phases, the distribution of different components and how they affect casting and working properties of the metals themselves. The principal focus of this first book in a series is on the alloys of copper with the elements silver, tin, zinc, nickel, antimony and arsenic. 358 pages, full colour throughout, indexed. To order your copy at the price of \$112 (US), £76 (English Pounds), or 88 Euros (Europe), please send cheque payable to author: Dr. David A. Scott, 2054 Walgrove Avenue, Los Angeles, California, 90066, USA. Incl. delivery: Europe £79 (English pounds) or 93 Euros (Europe and rest of the world).

## Websites

- **New** **Archaeological Iron Conservation Colloquium 2010** (24-26 June 2010, State Academy of Art and Design, Stuttgart) extended abstracts (Gerhard Eggert and Britta Schmutzler (Eds.)) are online:
  - [http://www.iron-colloquium.abk-stuttgart.de/Documents/Tagungsband\\_session\\_1.pdf](http://www.iron-colloquium.abk-stuttgart.de/Documents/Tagungsband_session_1.pdf)
  - [http://www.iron-colloquium.abk-stuttgart.de/Documents/Tagungsband\\_session\\_2.pdf](http://www.iron-colloquium.abk-stuttgart.de/Documents/Tagungsband_session_2.pdf)
  - [http://www.iron-colloquium.abk-stuttgart.de/Documents/Tagungsband\\_session\\_3.pdf](http://www.iron-colloquium.abk-stuttgart.de/Documents/Tagungsband_session_3.pdf)
  - [http://www.iron-colloquium.abk-stuttgart.de/Documents/Tagungsband\\_session\\_4.pdf](http://www.iron-colloquium.abk-stuttgart.de/Documents/Tagungsband_session_4.pdf)
  - [http://www.iron-colloquium.abk-stuttgart.de/Documents/Tagungsband\\_postersession.pdf](http://www.iron-colloquium.abk-stuttgart.de/Documents/Tagungsband_postersession.pdf)
- **New** **European Federation of Corrosion's Working Party 21:** dedicated to corrosion of archaeological materials <http://www.efcweb.org/Working+Parties/WP+21.html>
- **ANDRA:** Agence Nationale pour la Gestion des Déchets RadioActifs. The following documents can be ordered for free from this website: *Analogues archéologiques et corrosion* (French) and *Prediction of Long Term Corrosion Behaviour in Nuclear Waste Systems* (English) ([http://www.andra.fr/interne.php3?publi=publication&id\\_rubrique=82&p=produit&id=5](http://www.andra.fr/interne.php3?publi=publication&id_rubrique=82&p=produit&id=5)).
- **ARTECH network:** Network facilitating the access of conservation professionals to different investigation techniques for Cultural Heritage artefacts (<http://www.eu-artech.org/>).
- **BigStuff 2004:** Care of Large Technology Objects (<http://www.awm.gov.au/events/conference/bigstuff/index.asp>).
- **BROME C ListServ:** For direct email notification of BROME C publication web links and calls for submission of abstracts and announcements, simply subscribe with your preferred email address: <http://listserv.csv.warwick.ac.uk/mailman/listinfo/bromec-bulletin-of-research-on-metal-conservation>
- **CAMEO:** 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://cameo.mfa.org/>).
- **Cost Action G7: Artwork conservation by laser:** (<http://alpha1.infim.ro/cost>).
- **Cost Action G8: Non-destructive analysis and testing of museum objects:** Abstracts and booklets from previous workshops can be downloaded as well as announcements of past activities (Short Term Scientific Mission deadlines, training schools...) (<http://srs.dl.ac.uk/arch/cost-g8/>).

- **Cost Action D42: ENVIART:** Chemical Interactions between Cultural Artefacts and Indoor Environment. Register (free) to access all information (<http://www.echn.net/enviart/>).
- **Electrochemistry in Historical and Archaeological Conservation** (11-15 January 2010, Leiden, the Netherlands). The majority of presentations from this workshop held at the Lorentz Center (<http://www.lorentzcenter.nl/>), are available for download: <http://tinyurl.com/lorentzpresentations>
- **e-Preservation Science:** Online publication of papers in conservation science (<http://www.morana-rtd.com/e-preservation-science/>).
- **European Cultural Heritage Network:** European network of professionals interested in the conservation of Cultural Heritage (<http://www.echn.net/>).
- **Ge-Conservacion** is a periodical published by GEIC (Grupo Español de Conservación/Spanish Conservation Group of the International Institute for Conservation of Historic and Artistic Works: [www.ge-iic.com/](http://www.ge-iic.com/)) in association with the Duques de Soria Foundation. Its purpose is to contribute to the scientific development, dissemination and exchange of cultural heritage conservation and restoration knowledge: <http://ge-iic.com/revista/index.php?lang=en>
- **ICOMAM:** International Committee of Museums and Collections of Arms and Military History: (<http://www.klm-mra.be/icomam/>).
- **ICOM-CC Metals Working Group:** (<http://www.icom-cc.org/31/working-groups/metals/>). This site is for all official ICOM-CC Metals WG activities, forums, news, file downloads and information. The co-ordinator can email members from this site once members have registered on-line as a member of the Metals WG. Public access to this site is limited.
- **Incredible Industry:** The proceedings from the Nordic Association of Conservators 18<sup>th</sup> Conference, “Incredible Industry, Preserving the Evidence of Industrial Society” (25-27 May 2009, Copenhagen, Denmark) are now freely available online ([www.nkf-dk.dk/Bulletin/NKF-Incredible-industry09.pdf](http://www.nkf-dk.dk/Bulletin/NKF-Incredible-industry09.pdf)).
- **Industrial artifacts review:** Industrial design and the role of art and photography in promoting cultural heritage (<http://industrialartifactsreview.com/>).
- **Infrared and Raman for cultural heritage:** (<http://www.irug.org/default.asp>).
- **Laboratoire Pierre Sue:** LPS PhD thesis related to the alteration of archaeological artefacts can be downloaded in French. Follow the link to “Archéomatériaux et prévision de l’altération” (<http://www-drecam.cea.fr/lps/>).
- **LabS-TECH network:** (<http://www.chm.unipg.it/chimgen/LabS-TECH.html>).
- **METALCons-info:** Metals Conservation Information (<http://metalsconservationinfomation.wetpaint.com/>) is where the old METALCons-info site is being moved and redeveloped. This is a wiki based site, which means it can be grown by contributions from “writers” - i.e. you. Its power depends on how willing you are to use it. Each week it sends a summary of activity to members – so sign up! It is currently publicly visible, but this may change with any unwanted activity.
- **M2ADL:** Microchemistry and Microscopy Art Diagnostic Laboratory ([http://www.tecore.unibo.it/html/Lab\\_Microscopia/M2ADL/](http://www.tecore.unibo.it/html/Lab_Microscopia/M2ADL/)).
- **New York Conservation Foundation:** (<http://www.nycf.org/>).
- **PROMET:** A 3.5 year European 6th Framework funded project (21 partners from 11 countries around the Mediterranean basin) that developed conservation strategies for outstanding metals collections throughout the Mediterranean (<http://www.promet.org.gr>).

- **Restauración Metal Sur América:** (<http://www.restauraciondemetales.cl/>).
- **TEL: PhDs on line** (<http://tel.ccsd.cnrs.fr/>).
- **Yahoo Groups Metals Conservation:** A discussion group for all who are interested in Metals Conservation. Join in and make this a “Metals Cons-Dist List” (<http://groups.yahoo.com/group/Metals-Conservation-Discussion-Group>).

## National Contacts

- **Argentina:** Blanca Rosales ([brosales@fibertel.com.ar](mailto:brosales@fibertel.com.ar)), researcher, CIDEPINT, La Plata.
- **Australia:** David Hallam ([dhallam@nma.gov.au](mailto:dhallam@nma.gov.au)), senior conservator-restorer of objects, National Museum of Australia, Canberra.
- **Belgium:** Annemie Adriaens ([annemie.adriaens@ugent.be](mailto:annemie.adriaens@ugent.be)), researcher and lecturer, head of the group “Electrochemistry and Surface Analysis”, Ghent University, Ghent and Gilberte Dewanckel ([gilberte.dewanckel@kikirpa.be](mailto:gilberte.dewanckel@kikirpa.be)), conservator-restorer, Royal Institute of Artistic Heritage (Institut Royal du Patrimoine Artistique), Brussels.
- **Bulgaria:** Petia Penkova ([petiapenkova@yahoo.com](mailto:petiapenkova@yahoo.com)), conservator-restorer, National Academy of Arts, Department of conservation-restoration, Sofia.
- **Chile:** Johanna Theile ([jtheile@udd.cl](mailto:jtheile@udd.cl)), conservator-restorer and lecturer, Faculty of Art, University of Chile The Oaks (Facultad de Arte, Universidad de Chile Las Encinas), Santiago de Chile.
- **Croatia:** Zoran Kirchhoffer ([zoran.k@tehnicki-muzej.htnet.hr](mailto:zoran.k@tehnicki-muzej.htnet.hr)), conservator-restorer, Zagreb Technical Museum (Tehnički muzej Zagreb) and Sanja Martinez ([smartin@fkit.hr](mailto:smartin@fkit.hr)), electrochemist and lecturer, Faculty of Chemical Engineering and Chemical Technology, University of Zagreb (Sveučilište u Zagrebu), Zagreb.
- **Denmark:** Karen Stemann Petersen ([karen.stemann@natmus.dk](mailto:karen.stemann@natmus.dk)), conservator-restorer, The National Museum of Denmark (National Museet), Copenhagen.
- **Egypt:** Wafaa Anwar Mohamed ([wafaaanw@yahoo.com](mailto:wafaaanw@yahoo.com)), conservator-restorer, Giza.
- **Finland:** Pia Klaavu ([pia.klaavu@nba.fi](mailto:pia.klaavu@nba.fi)), conservator-restorer, National Museum of Finland (Suomen kansallismuseo), Helsinki.
- **France:** Elodie Guilminot ([elodie.guilminot@arcantique.org](mailto:elodie.guilminot@arcantique.org)), conservation scientist, Arc’Antique, Nantes.
- **Germany:** Britta Schmutzler ([britta.schmutzler@gmx.de](mailto:britta.schmutzler@gmx.de)), PhD “object conservation” student, State Academy of Art and Design (Staatliche Akademie der Bildenden Künste), Stuttgart.
- **Greece:** Vasilike Argyropoulos ([bessie@teiath.gr](mailto:bessie@teiath.gr)), assistant professor, Department of Conservation of Works of Art, Technological Educational Institution, Athens.
- **Hungary:** Balazs Lencz ([lenczb@gmail.hu](mailto:lenczb@gmail.hu)), senior conservator-restorer, Conservation Department, Hungarian National Museum (Magyar Nemzeti Múzeum), Budapest.
- **Italy:** Paola Letardi ([paola.letardi@ismar.cnr.it](mailto:paola.letardi@ismar.cnr.it)), scientist, Institute for Marine Corrosion of Metals (Istituto per la Corrosione Marina dei Metalli), Genova.
- **Morocco:** Hind Hammouch ([hamhind@yahoo.fr](mailto:hamhind@yahoo.fr)), scientist, Laboratory of Electrochemistry, Corrosion and Environment, Faculty of Science, Ibn Tofail University, Kenitra.
- **The Netherlands:** Ineke Joosten ([ineke.joosten@icn.nl](mailto:ineke.joosten@icn.nl)), conservation scientist, The Netherlands Institute for Cultural Heritage (Instituut Collectie Nederland), Amsterdam.
- **Norway:** Douwtje Van der Meulen ([d.l.v.d.meulen@iakh.uio.no](mailto:d.l.v.d.meulen@iakh.uio.no)), conservator-restorer, Conservation Department, University of Oslo (Universitetet i Oslo), Oslo.
- **Portugal:** Isabel Tissot ([isabel.tissot@archofactu.pt](mailto:isabel.tissot@archofactu.pt)), conservator-restorer, Portuguese conservation-restoration Institute (Instituto Português de Conservação e Restauro), Lisbon.

- **Romania:** Dorin Barbu ([barbu\\_dorin\\_laboratory@yahoo.com](mailto:barbu_dorin_laboratory@yahoo.com)), conservator-restorer, National Brukenthal Museum (Muzeul Național Brukenthal), Sibiu.
- **Russian Federation:** Andrey Chulin ([andrey\\_chulin@yahoo.com](mailto:andrey_chulin@yahoo.com)), conservator-restorer, the State Hermitage Museum, St Petersburg.
- **South Africa:** Jaco Boshoff ([jboshoff@iziko.org.za](mailto:jboshoff@iziko.org.za)), maritime archaeologist, Iziko Museums of Cape Town, South Africa.
- **Spain:** Emilio Cano ([ecano@cenim.csic.es](mailto:ecano@cenim.csic.es)), scientist, National Centre for Metallurgical Research (Centro Nacional de Investigaciones Metalúrgicas), Spanish Council for Scientific Research (Consejo Superior de Investigaciones Científicas), Madrid.
- **Sweden:** Helena Strandberg ([helena.st@comhem.se](mailto:helena.st@comhem.se)), conservator-restorer and conservation scientist, freelancer, Göteborg.
- **Switzerland:** Valentin Boissonnas ([valentin.boissonnas@he-arc.ch](mailto:valentin.boissonnas@he-arc.ch)), conservator-restorer and lecturer, Technical University (Haute école de conservation-restauration Arc), La Chaux-de-Fonds.
- **United Kingdom:** Maickel van Bellegem ([Mbellegem@thebritishmuseum.ac.uk](mailto:Mbellegem@thebritishmuseum.ac.uk)), conservator-restorer, British Museum, London and Mark Dowsett ([m.g.dowsett@warwick.ac.uk](mailto:m.g.dowsett@warwick.ac.uk)), physicist, University of Warwick, Coventry.
- **United States of America:** John Scott ([NYConsFdn@aol.com](mailto:NYConsFdn@aol.com)), New York Conservation Foundation, New York.