Green Conservation and E-RIHS

Sharing experiences of access to research facilities

Valeria Di Tullio

Institute of Heritage Science (CNR)

La cooperazione bilaterale italo-francese nelle scienze per il patrimonio: il patrimonio culturale nella transizione verde

Coopération bilatérale franco-italienne en sciences du patrimoine : le patrimoine culturel dans la transition verte

Consiglio Nazionale delle Ricerche, Piazzale Aldo Moro 7, Roma

giovedì, 15 settembre 2022 / *jeudi, 15 septembre 2022*

E-RIHS
EUROPEAN RESEARCH INFRASTRUCTURE FOR HERITAGE SCIENCE

www.e-rihs.eu
www.e-rihs.it

IPERION HS

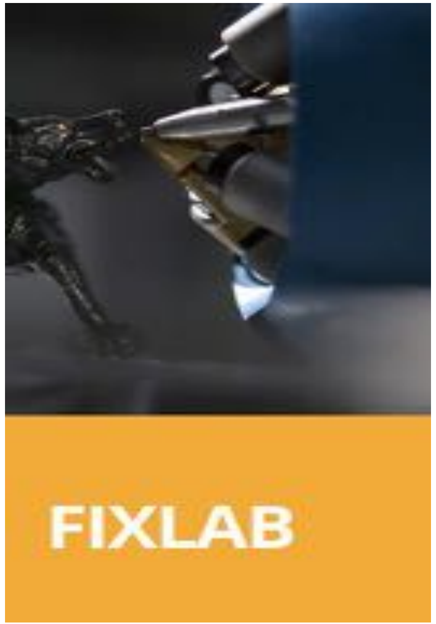
www.iperionhs.eu

The European Research Infrastructure for Heritage Science (E-RIHS) represents an advanced community that has been systematically developing since 1999 based on the work done in the framework of numerous EU projects to the current IPERION HS and E-RIHS IP.

E-RIHS entered the European Strategy Forum on Research Infrastructures (ESFRI) roadmap in 2016 as the unique project in the field of social and cultural innovation and is currently on its way to becoming pan-European distributed RI with the legal form of an European Research Infrastructure Consortium ERIC.

E-RIHS.it represents the national node of the distributed RI of E-RIHS in Italy coordinated by the Italian National Research Council (CNR) and supported by the Italian Ministry of University and Research (MUR).

- ✓ promotes interdisciplinary research with a strong societal impact by providing access to first-class expertise, digital data, reference collections, laboratories and mobile facilities to foster excellent science and innovation.
- ✓ seeks ways to optimally preserve heritage through understanding material change, and to harness its potential as a source of social, environmental, and economic benefit that tangibly contributes towards to sustainable development.
- ✓ responds to pressing global challenges impacting European society through supporting a better understanding, use and conservation of heritage







E-RIHS

Experiences of Access to research facilities

The role of multi-disciplinary collaboration between scientists, conservators, art historians and others is to promote the safeguarding of cultural heritage - be it tangible, intangible, digital or natural - and enhance its sustainability through better-coordinated research and innovation.

Here, some examples of collaboration for the conservation of cultural heritage are reported.

GREEN CONSERVATION and SUSTAINABILITY

"The conservation of cultural heritage refers to the measures taken to extend the life of cultural heritage while strengthening transmission of its significant heritage messages and values." (UNESCO 2009; ICCROM 1988.)

There is not a unique definition of green conservation. However, the following points are considered essential:

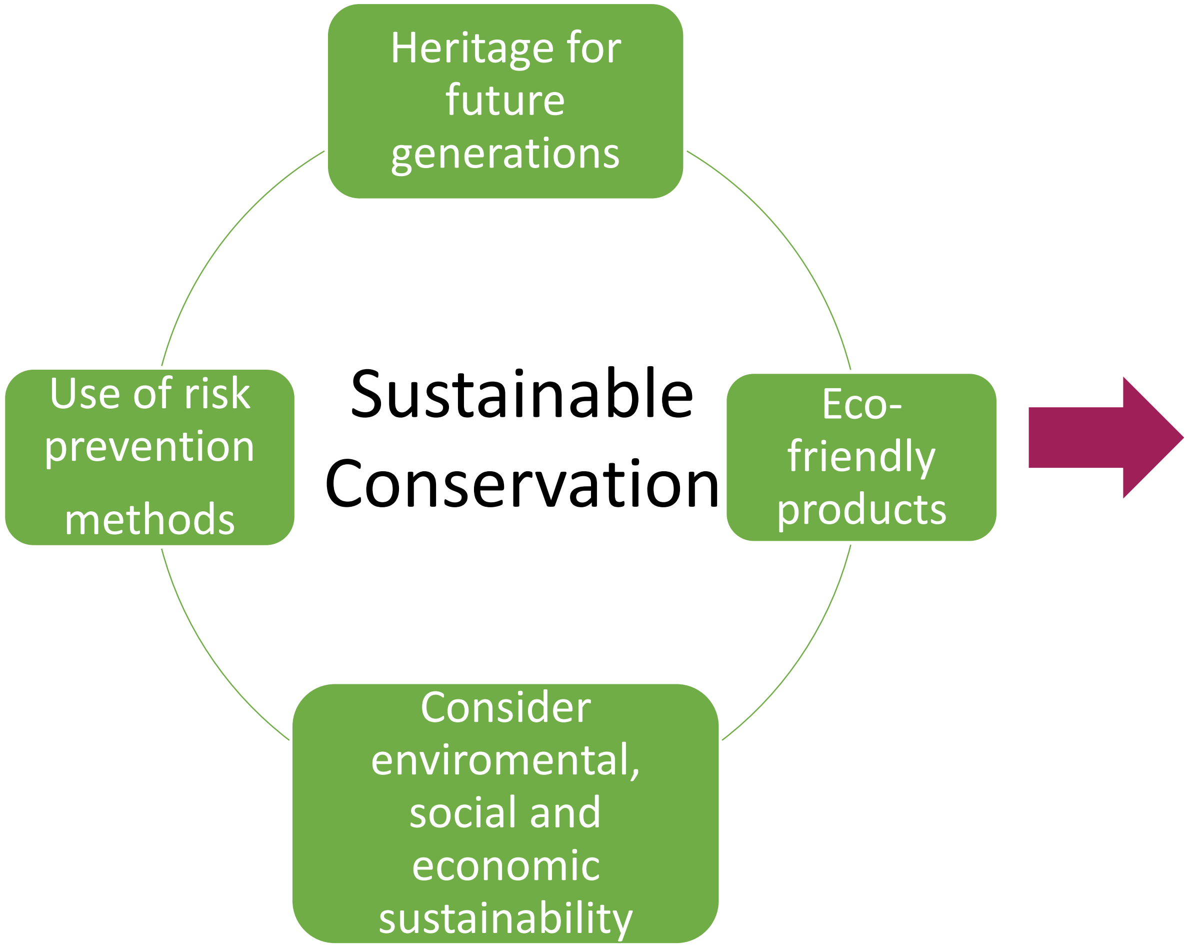


Fig. Adapted from Di Turo F., Medeghini L., *Sustainability* ***2021****,13, 3609*

1. To optimize and develop innovative products for conservation and restoration that respect both environment and operators; to evaluate safeness and effectiveness of new products for the materials of cultural heritage.

2. To implement and integrate innovative Technologies and methods for Monitoring outdoor/indoor conditions, to collect and manage data for providing predictive models of climate impact on cultural heritage and for planning best strategies of preventive conservation.

MOLAB

BIO-REMP PROJECT "Biorestoration of mural paintings"

*Study and evaluation of bacteria/hydrogel systems for cleaning mural paintings in the **Cappella Vitelleschi** of the **Tarquinia Cathedral.***

Among restoration procedures, the cleaning of artefacts is one of the most delicate and potentially damaging operation. High performing cleaning systems should have high physico-chemical stability, weak aggressiveness, environmental-friendly, and not toxic to the operator.

Furthermore, if the artefact experienced a number of retouching, a cleaning system should provide high selectivity between the materials to be removed and those to be preserved .

Aim of the present study was to evaluate the **effectiveness** and **harmfulness** of bacteria-based cleaning systems on mural paintings.

The restoration project was planned and conducted by Davide Rigaglia, and Valentina Romè.

Antonio da Viterbo, called Il Pastura (1450–

The monitoring of cleaning treatments and the characterization of the constitutive materials are fundamental steps in a restoration project as well as in evaluating new restoration products.

BIORESTORATION

BIO–REMP PROJECT

Biological methods that use microorganisms and enzymes as biological agents are attractive alternatives to the mechanical and chemical methods. They offer significant advantages in terms of soft intervention, **lack of health risks** for conservator-restorers **guaranteeing environmental safety**.

Selectivity, atoxicity, compatibility with constitutive materials and the environment are just a few distinctive characteristics of these procedures marking this biotechnology in line with the principles of compatibility and retreatability, which pertain to a more sustainable conservation strategy.

Among biotechnologies for cultural heritage, the uses of *Desulfovibrio vulgaris* bacteria are very quoted method to remove the sulphates from stone and monuments.

Advantages compared to traditional methods: more homogeneous removal of the surface deposits and preservation of materials under the black crust*.

Despite the increasing number of successful applications of *Desulfovibrio vulgaris* on different lithotypes little had been done on painted surfaces.

This method was developed by University of Milan and optimized by the spin-off company Micro4yoU Srl.

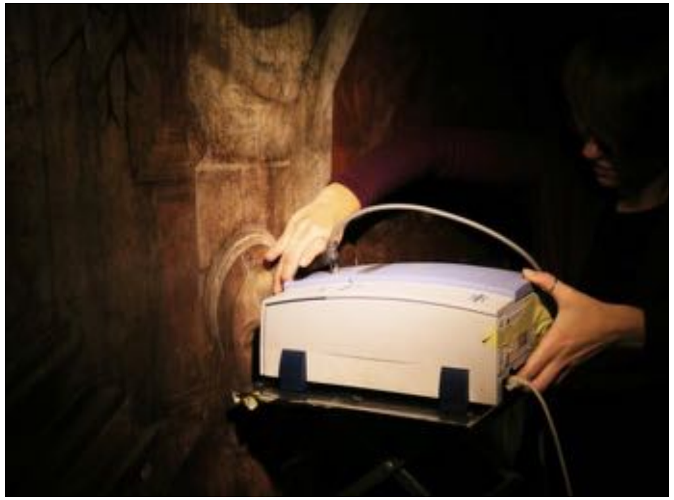
*Gioventù E., Lorenzi P.F., ***Procedia Chemistry***, Volume 8, **2013**,123-129

Gioventù E., Ranalli G., Orgeas E. V. **Il biorestauro. Batteri per la conservazione delle opere d'arte. Biopulitura e bioconsolidamento,** Nardini Ed.

MOLAB

Materials characterization and evaluation of degradation processess to optimaze the cleaning treatment.

1. The presence of aged organic finishes on the paintings (e.g wax used in previously restorations) could hinder or delay the action of the bacteria in removing the salt efflorescence;
2. The severe state of degradation, as high porosity, decohesion and micro-fractures, could facilitate the absorption of undesired residues of the treatment at the deeper depths of the plaster;
3. Daily fluctuation of micro-climate (apse of the Church) and residues of the cleaning treatment can trigger off undesired degradation processes (darkening, color change, micro-cracking).



Portable FT-IR spectroscopy

Chemical characterization of the materials was needed to planning the cleaning treatment and to study the potential interactions between the treatment and artwork.

Portable XRF

NMR

Evaluation of bacteria/hydrogel cleaning systems

MOLAB

After several tests, two different cleaning systems were prepared using bacteria mixed with two hydrogels commonly used by restorers (Carbogel and Vanzan gels).

The removal of salts efflorescence was evaluated by portable near FTIR spectra before and after the treatment.

To study the properties of two hydrogel/bacteria cleaning, and the diffusion of water in the painting portable NMR was also used.

Results indicated that the effectiveness of the cleaning system depended on the type of gel as well as the time of application, proving Carbogel was the best supporting material to subsume the bacteria suspension and convey bacteria through the porous structure.

Testing of several cleaning systems.
(Photo: Davide Rigaglia, Resp. restauro)

The access to research facilities and the availability of advanced portable methodologies during the restoration steps allowed restores to receive technological support for planning the best cleaning treatments by transferring knowledge and raising the awareness about using green methods.

Di Tullio V. , Sciutto G, Proietti N., Prati S., Mazzeo R., Colombo C., Cantisani E. , Romè V., Rigaglia D., Capitani D., *Microchemical Journal*, Volume 141, September **2018**, 40-50.

ARCHLAB

GOBIERNO DE ESPAÑA MINISTERIO DE CULTURA Y DEPORTE

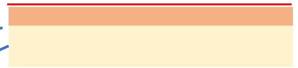
Access to Photographic collections at the Spanish Cultural Heritage Institute (IPCE) Archives and Photo Library: Stabilization and conservation treatments.

Alba Guerrero and Alexander Gaztañaga, **2017**
DOI [10.13140/RG.2.2.19201.07529](https://doi.org/10.13140/RG.2.2.19201.07529)

The ample variety of materials in negatives (glass, binders, silver salts, varnishes, etc.) and unique chemical behavior of each makes them difficult to preserve and limits the use of materials for their stabilization. **Their instability and fragility requires attention in the proper handling, storage and environmental conditions**

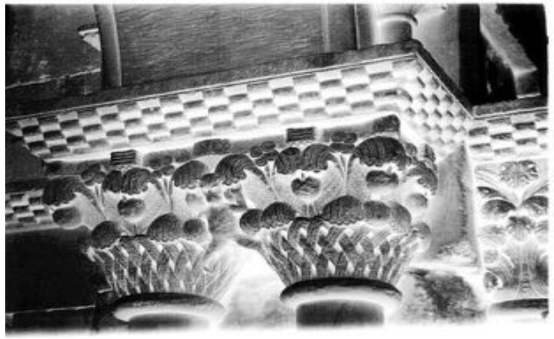
COLLOIDON GLASS PLATES

(1850) Ruiz Vernacci Archive



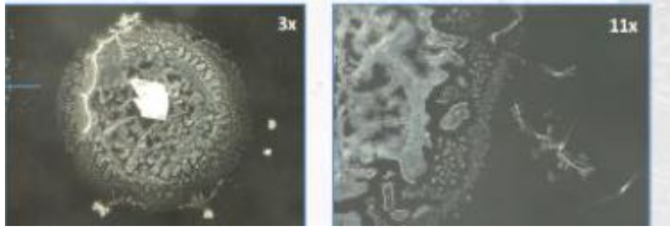
GELATIN GLASS PLATES

(1870) Moreno Archive



DETERIORATION AND DAMAGES

Physical | **Chemical** | **Biological**



BIOLOGICAL ATTACK

MATERIALS USED FOR PRESERVATION

Acid free, neutral pH Paper and Cardboard
- Consolidant adhesives compatible (glass and emulsion materials)
-Stable glass: Borosilicate glass B2O3 Greater resistance demonstrable to changes, thermical shocks and stronger physically.

Storage and long term preservation

Environmental conditions

Treatment monitoring

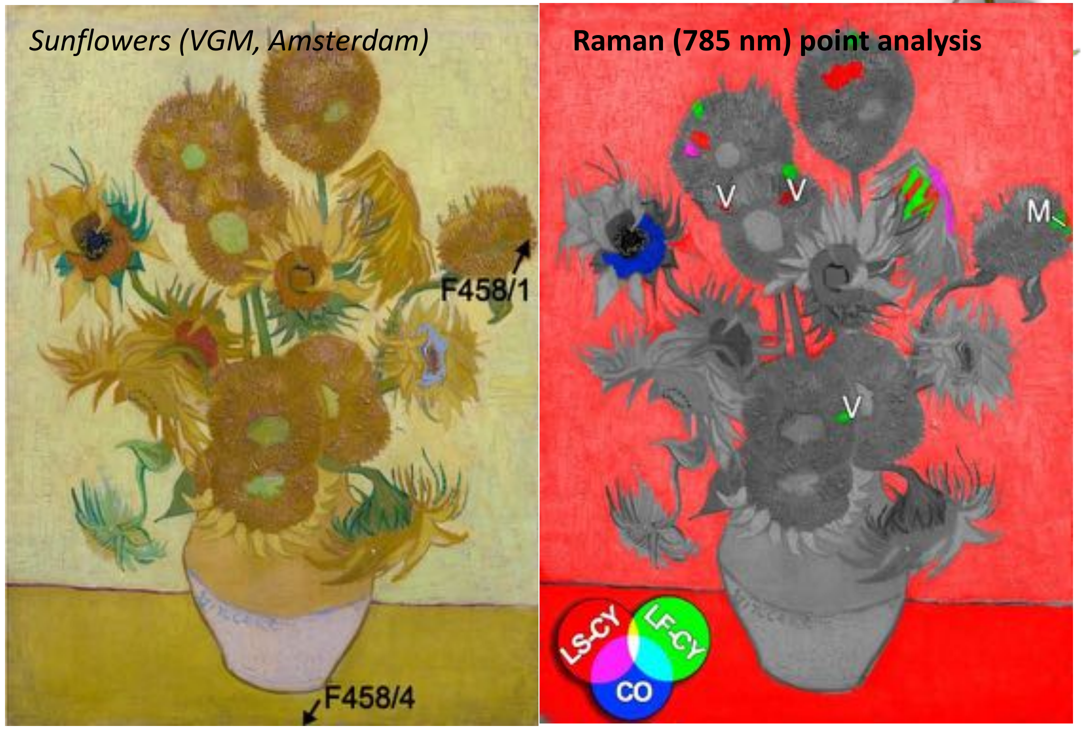
RH 30 – 40% Temp. 17 – 20ºC
- **Avoid fluctuations: ≤5%**
- **Control air quality** (combined concentration levels of bacteria and fungi not exceed biocontamination of 750 CFU · m^3)

MOLAB

Evidence for Degradation of the Chrome Yellows (CY) in Van Gogh's Sunflowers: A Study Using Noninvasive In Situ Methods by MOLAB

Photodegradation processes provoke long-term, cumulative and irreversible colour changes (fading, darkening, blanching) of which the prediction and prevention are challenging tasks

In several spots on the painting, FTIR and Raman spectroscopies combined with synchrotron-radiation-based X-ray investigations of two microsamples, revealed the presence of different types of chrome yellow used by Van Gogh, including the lightfast $PbCrO_4$ and a light sensitive sulfur-rich lead chromate ($PbCr_{1-x}S_xO_4$ ($x > 0.4$) variety that is known for its high propensity to undergo photoinduced reduction



LS-CY = Light Sensitive / LF-CY = Light Fast / CO = Cr orange

SCITEC

L. Monico et al, ***Angew. Chem. Int. Ed.*** 2015, 54, 13923 –13927; C. Miliani et al., ***Angew. Chem. Int. Ed***. 2018, 57, 7324 – 7334

MOLAB

Corrosion of metallic surfaces: Electrochemical Impedance Spectroscopy (EIS) with Gel polymer electrolyte cell (G-PE)

CENIM Centro Nacional de Investigaciones Metalúrgicas

CSIC Consejo Superior de Investigaciones Científicas

CSIC PTI-PAIS Patrimonio Abierto: Investigación y Sociedad

G-PE

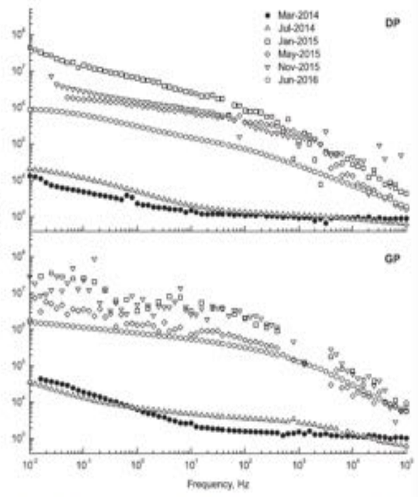
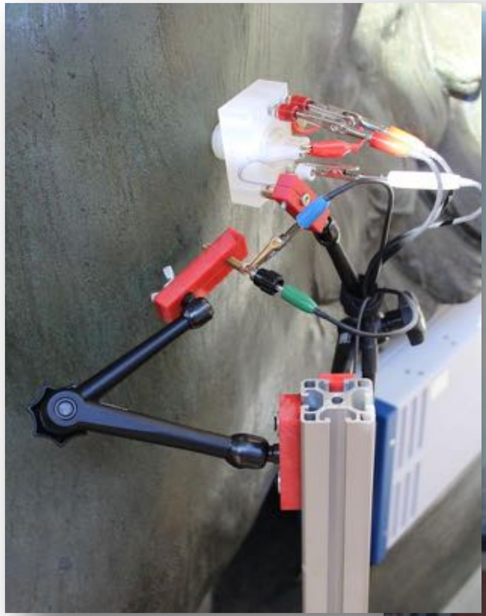


Fig. 4. Evolution of impedance modulus with time for dark patina (DP) and green patina (GP).



- EIS in combination with G-PE allows to **quantitatively assess the protective properties** of different coatings and application methods.
- The decrease of efficiency after natural or artificial ageing can be measured: **Evolution over time**
- This information can be used by conservators/restorers for coating selection & decisions maintenance.
- **Complemented** with chemical information (FTIR, XRD, Raman…) and morphogical information (OCT).

Barat B. R., Crespo A., García M., Díaz S., Cano E., ***Journal of Cultural Heritage,*** Volume 24, **2017**, 93-99.

Conclusions

Access to the research facilities E-RIHS facilitates the dissemination of new approaches of green conservation by sharing high-level scientific tools, data, advanced knowledge as well as innovative methodologies applied to the Cultural Heritage.

Thanks for your attention!

Valeria Di Tullio

Institute of Heritage Science
(ISPC-CNR)

valeria.ditullio@cnr.it

+39 0690672700

www.ispc.cnr.it