



ARCHLAB Access report

Project Title: GREEN CLEANING - Green solution to cleaning polychrome surfaces: enzyme and ionic liquids-based systems

Leading Researcher

Title: Dr. PhD Forenames: Irina Crina Anca Surname: Sandu

Institution: Universidade Nova – Faculdade de Ciencias e Tecnologia, Lisbon

Other members of project team participating in Access

Dr. Tito Busani

Dr. Stepanka Kuckova

Stud. Misa Chrova

Institution requested for ARCHLAB access

Opificio delle Pietre Dure, IT and Instituut Collectie Nederland, NL

Date of Access

OPD: 13/03/2011 to 18/03/2011 (Stepanka Kuckova); 02/05/2011 to 06/05/2011 (Tito Busani)

ICN: 15/05/2011 to 21/05/2011 (Irina Sandu and Misa Chrova)

Background to the project

Our project is being developed within a larger research context dealing with “Green” solutions for the conservation and investigation of works of art. The goal is to test several enzymes and ionic liquids for new formulations to be applied in the cleaning of polychrome surfaces with multi-layered structure and different coating systems.

The project is involving three research groups, two from Portugal (one from Lisbon, FCT-UNL and another one from Porto, FFUP) and one from the Czech Republic (ICT, Prague), bringing together different and complementary competences: conservation science, technical art history, biochemistry, enzyme technology and analytical chemistry.

Questions addressed by Access

The access to OPD and ICN was required based on previous knowledge of projects and researches that were performed in both institutions in the area of cleaning polychrome artifacts and on enzyme cleaning in particular. Based on the project's requirements, the access was intended to answer to questions like:

- How is better to apply an enzyme gel and which are the best exposure times and more efficient formulations;
- How to monitor the removal and clearance phases of the cleaning process;
- Which are the basic requirements and advantages vs. advantages of the analytical protocol for controlling the enzyme's action and for measuring whether this control is effective, using surface and micro-destructive analytical techniques;
- How to monitor the behavior (state and different parameters) of the painted surface before, during and after cleaning, through the complementary application of non-invasive analytical tools such as AFM, SEM and OM, colorimetry;
- How to monitor the effectiveness of cleaning using chromatographic and micro-destructive techniques (HPLC and MALDI-TOF-MS, cross-section observation) in order to understand

which changes occurred during cleaning on the painted surface, which is the depth of the cleaning and if there are any residues left from the enzyme or from the gel etc.

Specific aims of Access

Access was required for 4 persons to both institutions in order to provide:

- more knowledge (in terms of bibliographical references and methodology) on the information about enzyme cleaning of polychromes and painted surfaces, already existing in the archives and laboratories of OPD and ICN;
- knowledge on the already tested methodology (both of application of the enzymes but for monitoring its effectiveness, as far as the long-term effects of cleaning are concerned), especially addressed to OPD restorers dealing with enzyme cleaning;
- understanding on which are the best analytical tools and methodology of study of the polychrome surface before, during and after cleaning;
- understanding on the limitations of such a system of cleaning and of monitoring with analytical tools the effectiveness of this treatment;
- comparison with real case-studies from the OPD and ICN's current practice the potential of the enzyme formulations and of the analytical tools applied.

Description of the work carried out during the Access

The two visits at OPD in Florence (Dr. Stepanka Kuckova and Dr. Tito Busani) proved to be useful in updating the literature review information on enzyme cleaning and in receiving a good feed-back from restorers and scientists that dealt with this kind of cleaning on different substrates (Figure 1). The contact persons, Dr. Monica Galeotti and Dr. Giancarlo Lanterna, accompanied along the whole week the two members of our group.



Figure 1. Painting from the restoration laboratory of OPD during the treatment

The access to OPD's scientific archives enabled to Dr. Kuckova to find unpublished materials and diploma thesis of Cristiana Todaro (in Italian), where the applications of different types of enzymes (lipases, glycolytic enzymes, proteases) and preparation of their mixtures are described on model samples and also on medieval wall paintings. The direct contact with experienced restorers that already tested enzyme cleaning on paintings, wall paintings and statues gave more information on how this system works, which are the basic requirements during the enzymatic cleaning and which factors most influence the rapidity of the cleaning processes. A meeting with Dr. Cristiana Todaro directly at the place where she restores the outdoor wall paintings in the centre of Florence brought more valuable experiences. For instance, in the case of application of enzymes on the wall painting the most decisive factor is the outdoor temperature that significantly slows the cleaning procedure. The cost of the enzymes was also discussed and is one of the reasons for which they are not having a wider use.

Another meeting with Dr. Oriana Sartiani, the coordinator of the laboratory of paintings conservation, helped to understand and visualize the process of enzymatic cleaning, commonly used solvents and hardly soluble, layers of painting. She showed the efficiency of enzyme activity reacting directly on the painting surface without the harming of the following colour layers.

The stone restorers Isidoro Castello and Eleonora Gioventu showed a comparison of chemical (organic solvents), physical (laser) and biological (enzymatic) cleaning of black crusts from the statue surfaces. The most successful and less harmful was the method of using a special bacteria species that exclude sulphate reductive enzymes. Their usage is in any case limited by their complicated planting without the presence of oxygen and application on non-accessible places of artworks.

Dr. Lanterna showed a particular interest in the new surface and profiling techniques that modern instruments can provide and Dr. Busani (material scientist with almost no background in conservation) could understand, based on what he could see during the visit, how important the scientific tools are for the conservation field and what exactly the practical conservation means. Therefore, the exchange of information during the discussion with Dr. Lanterna proved to be very useful for understanding the advantages and limitations of the nano-scale tools for conservation applications.

Dr. Oriana Sartiani spoke to Dr. Busani about her previous work with enzymes and bacteria, even if she informed that those methods are not yet fully used in the lab. She did a demonstrative session on real time cleaning on real paintings and she showed availability to provide access to real objects on which the enzyme-ionic liquid formulations could be tested, once the method will be fully developed on model samples.

Dr. Busani had also access to the library of the Scientific Laboratory of OPD and he could find specific bibliography on gilded artefacts, gold leaf application methods, and on enzyme cleaning. These materials were searched among the publications recognized in the field such as "Studies in conservations", "Reviews in conservation" and books published by The Getty Conservation Institute.

The visit at ICN in Amsterdam (Irina Sandu and stud. Misa Crhova) was especially conclusive on the requirements and concerns for the application of a non-invasive methodology of monitoring the changes of the polychrome and/or painted surface after cleaning with enzyme gel formulations.

In the first day, Irina Sandu gave a lecture of 30 minutes on the project and her work at NOVA University and a plan was established for the next days, as short meetings with different specialists or practical work session with the two proposed instruments (Hirox 3D microscope and SEM-EDS). In this respect, the collaboration of Dr. Ineke Joosten, who kindly organized the visit, was particularly useful for demonstrating the application of Hirox 3D digital microscope coupled with SEM-EDS imaging and mapping on the fourth day (Figure 2).



Figure 2. The two instrumental set-ups and their use during the visit at ICN

The second and third day were used for bibliographical research in the library of the Institute, with a particular focus on Proceedings from Conferences and chapters from books dealing with gel and enzyme cleaning. A meeting with Henk van Heulen, a specialist on GC-MS, was organized and he presented the achievements of a dry cleaning project for un-varnished painted surfaces, discussing also the analytical and methodological aspects related to this project. Another meeting was organized on Friday with Dr. Klaas Jan van den Berg and he spoke about mass-spectrometric assessment of residues from oil paintings and an ongoing project on cleaning sensitive oil painting surface. The fifth day was also used to conclude the bibliographical search in the library and to deal with bureaucratic matters (reimbursement) at ICN.

Achievements from the Access

The main achievements from the access to the two institutions were:

- new bibliographical references (more than 25) as master thesis, published papers and chapters of books on the cleaning practice and formulations based on gel and enzyme cleaning;
- meeting and discussions with specialists from OPD (restorers, such as Dr. Oriana Sartiani and scientists, such as Dr. Giancarlo Lanterna) on the use of enzymes in cleaning paintings and other types of artefacts, the limitations of this kind of applications and the current methodologies for evaluating cleaning used at OPD,
- analytical data obtained on some model samples (before and after cleaning with two commercial formulations) with Hirox 3D microscope and SEM-EDS at ICN (collaboration of Dr. Ineke Joosten);
- critical discussions on the purpose and practical use of enzyme-ionic liquids formulations on real objects;
- visits to the laboratories and libraries from both institutions and exchange of information about research topics and projects with the specialists working there.

Potential future research and/or plans for dissemination

The exchange of theoretical and practical expertise between our groups and the staff from OPD and ICN will for sure increase the scientific output of the project and will foster lasting international science cooperation.

The results obtained from the project and the bibliography found in the archives and libraries of OPD and ICN will be used for publications with peer-review process and presentations to conferences. Two applications for a poster presentation (to a workshop to be held in Porto, Portugal in September) and a paper are in progress. Dr. Ineke Joosten will be co-author for the paper as she provided useful analytical data from the analyzed samples.

The successful formulations (enzyme+gel/+ionic liquid) obtained from the research will be proposed during seminars and workshops held at the University in Lisbon and also in collaborations already established with public and private laboratories of restoration in Portugal and abroad. In this respect, a special attention will be given to the collaboration with Dr. Oriana Sartiani, that showed availability to test them on real paintings and other polychrome surfaces.

Signature of leading researcher:

