Nanotechnologies in the Conservation of Cultural Heritage

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Nanotechnologies in the Conservation of Cultural Heritage

A compendium of materials and techniques

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Preface

The idea of writing this book, mainly aimed at practitioners in the field of Cultural Heritage preservation, came from continuous interaction with conservators and their requirement for practical guidelines on the use of nanomaterials for conservation. Accordingly, this compendium deals with both the fundamental principles and practical usage of different innovative nanomaterials for several classes of common movable and immovable artistic substrates. The ideal audience comprises all the conservation end-users, such as freelance conservators and restorers, personnel and experts of conservation institutions and museums, and also students of restoration schools (including universities and colleges that adopted conservation programs) and scientists who are willing to approach the conservation of artifacts, historical objects and works of art.

The methodologies developed by the authors in the last decades are described with a clear approach that is accessible also to readers and end-users that might come from humanistic or artistic areas and are not familiar with chemistry and advanced conservation systems/technology, while maintaining scientific rigor and providing references to advanced material science. The reported methodologies for the consolidation, cleaning and deacidification of artifacts, cover a significant and representative part of the case studies met in Cultural Heritage preservation. The approach described is based on the use of advanced systems (derived from colloid and soft matter science) applied to practical restoration needs, in fact most of the methods reported in this compendium have already been used in restoration facilities, workshops and ateliers worldwide.

The conservation systems described in this compendium represent a significant improvement on traditional conservation methodologies because the proposed advanced systems exhibit enhanced properties, namely:

- High physico-chemical compatibility with the constituents of works of art, i.e. the application of the advanced systems minimizes or completely avoids any alteration of the original physical and chemical properties of the artistic/historical substrates.
- The proposed nanomaterials are either non-toxic or they exhibit a significantly reduced toxicity as compared to traditional restoration materials such as pure solvents or solvent blends.

- The use of advanced nanomaterials allows greater control of the restoration intervention, for instance highly controlled cleaning can be carried out using microemulsions and chemical hydrogels as compared to traditional cleaning methods.
- The innovative methodologies proposed in the compendium are feasible and reliable, and in many cases simpler and faster than traditional methods. In some cases methods are proposed where a gradual and slower approach is necessary to grant stability of the treated artifact also in the long term (as opposed to "quick" traditional interventions that might involve drawbacks, requiring later interventions).

Even though the proposed application of the advanced systems is feasible, the development of these systems derives from scientific knowledge of sometimes complex concepts. Moreover, it must be noticed that some of these systems are self-assembly under a range of conditions (temperature, pressure, composition, etc.), and their production requires fine knowledge of phase behaviors. Therefore, it is highly inadvisable to modify the original systems through empirical and trial-and-error procedures, as the composition and practical use suggested by the authors of this compendium already grant the best conditions for optimal efficiency. The arbitrary modification of these systems involves the risk of reducing their effectiveness, and in some cases this might result in potentially detrimental effects on the treated works of art. Conservators and end-users are thus encouraged to use the proposed materials and methodologies as they have been described in the dedicated chapters, and to contact the authors of this compendium for further guidance and recommendations on the use of these formulations. We believe, in fact, that the synergistic cooperation between different disciplines and skills is a fundamental step in the conservation of cultural heritage.

The compendium contents are structured as follows: first, an overview is provided about the main nanomaterials developed in the last 30 years (dispersions of nanoparticles, micellar solutions, microemulsions and gels), explaining their main features and applicability. Then, specific chapters are dedicated to artistic/historical substrates (e.g. wall and easel paintings, stone, paper, canvas and wood), dealing with the main artifacts degradation processes and then discussing practical applications and guidelines for the cleaning, consolidation, or deacidification of works of art.

Throughout the writing of this compendium we have been in contact with colleagues, both colloid/soft matter scientists and conservators, who are gratefully acknowledged for discussion and support as we were engaged in the effort of describing simple yet comprehensive applicative methodologies. We also wish to acknowledge the European Union (which has financed the FP7 project "Nanoforart") for partly supporting some of the activities that ultimately led to the development of practical protocols for the use of nanomaterials in conservation of Cultural Heritage.

Florence, July the 18th, 2014

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Contents

1 Innovative Nanomaterials: Principles, Availability and Scopes 1
1.1 Nanotechnology for Cultural Heritage Preservation 1
1.2 Nanoparticles 3
1.3 Nanostructured Cleaning Fluids 6
1.4 Gels 8
References 13

2 Consolidation of Wall Paintings and Stone 15
2.1 Background 15
2.2 Formulations 22
2.2.1 Formulations for Wall Paintings 23
2.2.2 Formulations for Stone 33
2.3 Application Field 38
2.4 Application Procedures 41
2.4.1 The Ferroni Method 43
2.4.2 Application of Nanoparticles Dispersions 47
References 56

3 Cleaning of Wall Paintings and Stones 61
3.1 Background 61
3.2 Formulations 71
3.3 Application Field 74
3.4 Application Procedures 75
References 81

4 Cleaning of Easel Paintings 83
4.1 Background 83
4.2 Formulations 89
4.3 Application Field 104
4.4 Application Procedures 106
References 114

5 Deacidification of Paper, Canvas and Wood 117
5.1 Background 117
5.2 Formulations 130
5.3 Application Field 135
5.4 Application Procedures 137
References 141

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Piero Baglioni is a full professor of Physical Chemistry and lecturer of Physical Chemistry at the Department of Chemistry of the University of Florence. He is the Director of the Center for Colloid and Surface Science (Consorzio Interuniversitario per lo Sviluppo dei Sistemi a Grande Interfase—CSGI); he is in the Advisory Board of several international journals, International organizations, and member of several national and international institutions, industries, and learned societies (e.g the European Academy of Science; the Royal Academy of Art and Science in Göteborg, Sweden; the American Chemical Society; the European Colloids and Interface Society; the European Society for Neutron Spectroscopy; Accademia delle Arti del Disegno—the oldest Academy in Italy). Piero Baglioni is author of about 400 publications on books and journals and 26 patents (5 of which in connection with art restoration). He was recipient of international prizes for his contribution to Conservation of Cultural Heritage and to the synthesis of nucleolipids, such as Lifetime achievements for the contribution to Colloids and Interface Science (JCIS), the Caballero Aguila (The most prestigious recognition from National agency for conservation in Mexico), the Gran Prix for Innovation Award and from the European Colloids and Interface Society (ECIS). The methods for the conservation of artistic and historical objects introduced by his group have been widely acknowledged.

David Chelazzi received his Master's degree in Chemistry at the University of Florence in 2003, with a thesis work developed at the European Laboratory for Non-Linear Spectroscopy (L.E.N.S.). In 2007 he received his PhD on Science for Cultural Heritage Conservation at CSGI, on the development of physico-chemical methodologies for the conservation of paper and wood works of art. Post-doc experience included a scholarship at the "Centre de Restauration des Musées de France" (C2RMF) in Paris (Palais du Louvre), on the aging and removal of adhesives used for the lining of paintings.

As of 2010 he is a Research Fellow at CSGI—Department of Chemistry of the University of Florence, his research work focuses on the development of nanomaterials for the conservation and preservation of movable and immovable works of art. He is the author of 30 publications in the field of conservation of cultural heritage materials.

Rodorico Giorgi received his degree in Chemistry (physical-chemistry curriculum) in 1996, at the University of Florence, and in 2000 his PhD in Science for the Conservation of Cultural Heritage at the same University, with Prof. Piero Baglioni as Advisor. He is currently research fellow at the Department of Chemistry of the University of Florence and CSGI, national Center for Colloid and Surface Science. Giorgi's main research interests are in physico-chemical characterization of materials, investigation of degradation processes and development of nanotechnology for the conservation of different works of art materials, such as wall and canvas paintings, stone, paper, parchment, and archaeological wood. Giorgi is author of about 100 publications in the field of nanoscience application to cultural heritage conservation.

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