APACHE

Active & intelligent PAckaging materials and display cases as a tool for preventive conservation of Cultural HEritage.

SECOND PUBLIC TRAINING

Centro Conservazione e Restauro "La Venaria Reale" Venaria Reale – Turin - Italy

Dec. 2 & 3 2021

APACHE

*Active & intelligent PAckaging materials and display cases
as a tool for preventive conservation of Cultural HEritage.*

Degradation of movable, tangible and indoor cultural heritage can be significantly increased by disadvantageous and unstable climate conditions, light, and intrinsic or external pollution. Preventive conservation aims to minimize aging and degradation by optimizing, among other, display and storage solutions. In the recent years, several active and intelligent packaging materials have been developed and put to use, especially in food industries. However, these materials are short-term solutions that cannot be easily adapted for cultural heritage, where long-term stability is mandatory. In the APACHE proposal, the novel combination of active novel packaging materials, developed based on materials modelling, with sensors and wireless sensor technologies (WST) provides smart, low-cost easy-to-deploy systems for storage and exhibition of cultural heritage objects. One of the main goal of APACHE is to dramatically reduce the costs of mechanical climate control and monitoring systems, by developing and customising smart and affordable novel materials, based on material science advancements and discrete and continuum modelling.

The training organized by the European project APACHE and by the Fondazione CCR "La Venaria Reale" aims to explore the consortium activities, to spread knowledge generated during the development of the project within academic, professional, potential users and industrial domains in addition to upskill key stakeholders and staff on the use of the novel materials/tools/solutions applied to the preventive conservation of cultural heritage.

THE TRAINING FOCUSES ON THREE ESSENTIAL SECTIONS:

- *Five practical workshops around the application methodologies and the use of some developed technologies*
- *Lectures and presentations on the theoretical, research and implementation aspects of the novel materials and solutions*
- *A final open debate about the new materials, feedback and sharing of experience after the practical activities*

FIRST DAY

09:00 – 09:10: Greetings

Sara Abram, CCR "La Venaria Reale", Venaria Reale, Turin.

Preventive conservation: research and practicalities.

CHAIR: FEDERICA POZZI,
CCR "La Venaria Reale", Venaria Reale Turin.

09:10 – 09:30 Isella Vicini:

Cultural Heritage: funding opportunities in the new framework programme for research and innovation, Horizon Europe (2021-2027).

09:30 – 09:50 Michela Cardinali:

The CCR experience in the preventive conservation of historic house museums: knowledge, management and training for a sustainable approach.

09:50 – 10:10 Oscar Chiantore:

Indoor air quality in museums showcases: materials interactions, off-gasing, impacts.

10:10 – 10:30 Ida Kraševec:

Monitoring protocols for pollutants in museums.

10:30 – 10:45 Q&A

10:45 – 11:00 Coffee break

Modelling and decision-making.

CHAIR: RODORICO GIORGI,
UNIFI, CSGI, FLorence.

11:00 – 11:20 Matija Strlic:

Modelling preventive conservation outcomes.

11:20 – 11:40 Aysenur Iscen and Nancy C. Forero-Martinez:

Acrylic paints under the computational microscope.

11:40 – 12:00 Ebrahim Norouzi:

APACHE APP interfaces for cultural heritage interoperable multi-scale simulation workflows.

12:00 – 12:20 Alex Zabeo:

Apache Decision Support System supporting preventive conservation actions.

12:20 – 12:40 Q&A

12:40 – 14:00 Lunch break

Materials developed in the APACHE project to influence the environment.

CHAIR: PATRIZIA TOMASIN,
CNR, Padova.

14:00 – 14:20 Piero Baglioni:

Innovative "green" gels as new pollutant absorbers in Preventive Conservation.

14:20 – 14:40 Maria Paola Staccioli:

Multifunctional materials based on chitosan for the removal of degrading species in museum storage/display environments.

14:40 – 15:00 Panagiotis Goulis and Dimitrios Dragatogiannis:

Humidity sorption study using PVA membranes and Super Absorbent Polymers.

15:00 – 15:20 Costas Galiotis:

Roll-to-roll graphene transfer as an effective tool for the protection of artworks

15:20 – 15:35 Q&A

15:35 – 15:50 Coffee break

Sensors and solutions to describe and interact with the environment.

CHAIR: STEFANO DELLA TORRE,
Politecnico di Milano

15:50 – 16:10 Marco Girolami:

Sensitive and selective electrochemical sensors for monitoring the atmosphere of display cases and crates in museums.

16:10 – 16:30 Daniela Iacopino:

Flexible and bendable sensor platforms for monitoring of heritage artworks.

16:30 – 16:50 Dinesh R. Gawade:

A battery-less NFC sensor transponder for museum artefact monitoring.

16:50 – 17:10 Manfred Anders and Steffen Ziemann:

Converting conventional passive into novel active archive boxes.

17:10 – 17:30 Q&A

SECOND DAY

09:30 – 11:00

First cycle of practical activities.

Manfred Anders and Steffen Ziemann:

Integration and practicability of regulators and sensing devices in archive boxes.

Dinesh R. Gawade:

A battery-less NFC sensor transponder for museum artifact monitoring. Demonstration.

Piero Baglioni and David Chelazzi:

Innovative "green" gels as new pollutant absorbers in Preventive Conservation.

Alex Zabeo:

APACHE Decision Support System application in real collections case studies.

Josep Grau-Bove and Himantha Cooray:

Using a decision making-tool to select the best storage enclosure.

11:00 – 11:15 Coffee break

11:15 – 12:45

Second cycle of practical activities.

12:45 – 14:00 Lunch break

14:00 – 15:30

Third cycle of practical activities.

15:30 – 15:45 Coffee break

15:45 – 17:15

Open debate about the new materials, feedback and sharing of experience after the practical activities.

Objectives of the APACHE project

Promote preventive conservation solutions characterized by low environmental impact, with higher quality/price ratio than current standards.

Enhance the digital museum revolution with the possibility to check remotely the behaviour of display cases, storage crates and archival boxes.

Develop effective and intelligent solutions that have an active influence on micro environment inside boxes, crates and showcases.
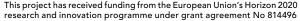
Implement solutions in terms of new materials regulators of temperature, relative humidity and pollutants.

Develop novel sensors for microenvironmental monitoring.

Creation of an application to support decision making and interventions by personnel tasked with collection conservation.

Prediction of cultural heritage degradation based on material modelling and mathematical functions.

Organize and encourage knowledge transfer, greater public awareness, transparency, and education through a wide range of dissemination and communication activities.

ABSTRACTS AND SHORT CV

SECTION 1:
Preventive conservation: research and practicalities

Isella Vicini[+]

Warrant Hub S.p.A., Correggio (RE), Italy
+ Presenting and corresponding author
email: isella.vicini@warranthub.it

Cultural Heritage: funding opportunities in the new framework programme for research and innovation, Horizon Europe (2021 – 2027).

The EU has supported research and innovation in cultural heritage in its various forms - tangible, intangible and digital - through its framework programmes since 1986. Horizon Europe, starting on January 2021, is the 9th framework programme that will bring new inputs and will give new perspectives to innovation in the Cultural Heritage field, opening new opportunities of funding thanks to specific instruments such as the Innovation Fund and the EIC accelerator. Moreover, the next 7 years of Horizon Europe will be focused on environment and sustainability and new opportunities will open also for Cultural Heritage inside the European Green Deal and LIFE Programme. Isella Vicini will give an overview of funding opportunities and instruments for the cultural heritage sector, explaining how to make the most of European funding programmes.

Isella Vicini is the Director of the European Funding Development of Warrant Hub S.p.A and the CEO and founder of beWarrant, a Belgian consultancy company that provides support on European Funding opportunities. She has a wide experience in the EC Research and Innovation programmes, like Horizon 2020 and LIFE Programme. Since the First Framework Program (1985), she works in the European Project Design field, taking care of the complete cycle of a project: from the analysis of the sectorial policies to the conclusion of the research and innovation project. She currently manage a team of 16 people and her European Funding Development provides 80 consultancy services per year, it is involved in 51 projects and it manages 151 million euros Horizon 2020 grant. Isella is the Project Coordinator of the EU funded project Repair3D and the founder and Dissemination Manager of ECHOES, the EC Cluster on Cultural Heritage.

Michela Cardinali[+]

Centro Conservazione e Restauro "La Venaria Reale, Venaria Reale, Turin, Italy
+ Presenting and corresponding author

email: michela.cardinali@centrorestaurovenaria.it

The CCR experience in the preventive conservation of historic house museums: knowledge, management and training for a sustainable approach.

Since its establishment, the Conservation and Restoration Centre "La Venaria Reale" (CCR) has developed activities aimed at the preventive conservation of historical residences, monuments, archaeological sites and different types of artifacts. In particular, since 2006, it has launched shared plans for documentation, technical-scientific monitoring and planned maintenance, aimed at the prevention and conservation of architectural surfaces and works of art located in the historic Piedmontese residences. On the basis of these experiences, the CCR took part in international and national projects, focusing its attention on the integrated management process that implements the conservation actions and training and educational initiatives able to disseminate good practices. Increasingly, the development of these projects invites us to reconsider the need for sustainable development tools, systems and development plans that can support different organizations in the long term.

Michela Cardinali received her degree in 2000 at the ICR in Rome where she began her professional career. Subsequently she obtained a Degree in Technology for the Conservation and Restoration of Cultural Heritage and in 2006 she began working at the Centro Conservazione e Restauro "La Venaria Reale" (CCR) as a specialist conservator in the field of natural and derived stone artefacts and paintings on canvas and panel, and as a teacher of the Master's Degree Course in Conservation and Restoration of Cultural Heritage at the University of Turin, as part of the vocational training course dedicated to stone materials and decorated architectural surfaces. Since 2011 she is Director of the 8 CCR conservation laboratories and since 2013 Head of the Advanced Training and Study School.

Oscar Chiantore[+]

Goppion S.p.A., Trezzano sul Naviglio, Milan, Italy
+ Presenting and corresponding author
email: oscar.chiantore@unito.it

Indoor air quality in museums showcases: materials interactions, off-gassing, impacts.

The control of air quality in museum showcases is of growing importance for the conservation of the displayed artefacts. Inside an airtight showcase volatile substances may rapidly concentrate and favour or directly cause degradation or other unwanted phenomena on the objects. The role of materials, either used for construction and decor of the museum display cases or being artworks constituents, as source of pollutants and volatile compounds dangerous for the cultural heritage integrity will be discussed with illustration of consequences and critical damages. Ways of assessing the suitability of materials used either in the construction and use of the display cases are also critically examined, altogether with an overview of the possible choices for monitoring the air quality and limiting the concentration of volatile compounds in their interior.

Oscar Chiantore is scientific consultant and research project manager with the Goppion company. Research scientist and past Chair of Chemistry and Technology of Polymers at the University of Torino. Chairman of the Curriculum in Science and Technology for Cultural Heritage at the University of Torino from 2001 to 2006. Chairman of the Interfaculty School in Conservation - Restoration of Cultural Heritage, University of Torino and Centro Conservazione e Restauro La Venaria Reale, from 2006 to 2012. Former active member of the IUPAC working group on "Characterization of Industrial Polymers" and of the UNI-NORMAL Commission for protection of stone artefacts. Emeritus Governing Board Member of ISPAC, international organization for research in the field of polymer characterization. His research specialization in polymer science is about the chemistry, characterization and degradation behaviour of macromolecular compounds, with particular attention at the analysis and properties of organic compounds in cultural heritage, at the design, development and testing of new polymers as coatings, adhesives or consolidants for conservation applications, the ageing and conservation of polymer materials in contemporary art, the emission and control of volatile compounds from polymers and from organic based materials in general.

Ida Kraševec[+]

University of Ljubljana, Ljubljana, Slovenia
+ Presenting and corresponding author

email: Ida.Krasevec@fkkt.uni-lj.si

Monitoring protocols for pollutants in museums

The presence of pollutants in the indoor air is known to contribute to the degradation of heritage objects stored or displayed in heritage institutions. Among these, acetic and formic acids are known to have harmful effects on pigments and metals, as well as on some objects of organic origin. In the course of the APACHE project, we developed and validated several methods for monitoring of pollutants in museum environments, based on passive sampling. The methods were used in collaboration with seven European museums, where pollutant monitoring was performed in every season of the year.

Ida Kraševec is a researcher at the Department of Analytical Chemistry at University of Ljubljana, where she also obtained her PhD. Currently she focuses on developing methods for characterisation of compounds, emitted from heritage objects and the surrounding materials based on both active and passive sampling techniques.

SECTION 2:
Modelling and decision-making

Matija Strlič[+]

University of Ljubljana, Ljubljana, Slovenia
+ Presenting and corresponding author
email: matija.strlic@fkkt.uni-lj.si

Modelling preventive conservation outcomes

The two schools of decision-making, synoptic and incremental, each have followers in preventive conservation. Incremental decisions are based on the notion that solutions are very complex, that decisions therefore do not have an end goal in themselves, and that the process is ongoing. In contrast, synoptic decision making requires an assessment of possible outcomes, based on which the optimal choice can be made within given practical constraints. This is desirable, as it increases transparency and can respond to rapid and significant shifts in management. For some heritage materials and collections such decision making is possible, since we know how to model the consequences of conservation decisions, e.g. the long-term effects of a 4 oC, or 10% RH, or 10 ppm NO2 decrease. This can be achieved by using damage functions, and some of these have been made available as online apps, which the presentation will introduce.

Matija Strlic is Professor of Heritage Science at University College London, Professor of Analytical Chemistry at University of Ljubljana and Senior Research Fellow at the Smithsonian's Museum Conservation Institute. His research focuses on heritage materials and collections, as well as their interactions with the environment. His current interests include development and use of damage functions and integrated modelling of heritage collections. He published more than 160 peer-reviewed papers in the field of heritage science, the majority of which are related to conservation and degradation of organic materials. He is an accredited conservator, Fellow of the International Institute for Conservation and Fellow of the Royal Society of Chemistry.

Aysenur Iscen[+] and Nancy C.Forero-Martinez[+]

Theory Group, Max Planck Institute fo Polymer Research, Mainz, Germany
+ Presenting and corresponding authors
email: iscena@mpip-mainz.mpg.de and forero@mpip-mainz.mpg.de

Acrylic paints under the computational microscope

Damage in cultural heritage conservation emerges from the interplay of various complex processes occurring at the microscopic scale. Through a multi-scale computational methodology, we aim at a fundamental understanding of these processes in acrylic materials present in both contemporary paintings and storage packaging. We focus on the canvas' paint layer and recreate environmental and storage conditions at the molecular scale. Hence, we explicitly include the polymers used as binders in the acrylic paints and prototypical volatile organic compounds (VOCs). Here, we discuss the interaction between polymers and VOCs as a diagnostic tool to quantify the impact on the materials lifetime.

Aysenur Iscen is a postdoctoral researcher working under the supervision of Kurt Kremer at the Max Plank Institute for Polymer Research. She earned her B.S degree in chemical engineering from Yeditepe University in Istanbul, Turkey. She completed her PhD in chemical and biological engineering with Prof. George C. Schatz at Northwestern University in 2019, where she developed computational methods to develop bio-inspired materials.

Nancy C. Forero-Martinez is a postdoctoral research assistant in the Theory Group at the Max Planck Institute for Polymer Research. She earned Physics and MSc. degrees at the Universidad Nacional de Colombia and a PhD degree at Queen's University Belfast. Her research focuses on studying the optical, electronic and structural properties of nanoscale materials using multiscale simulations. Currently, she investigates the thermodynamic and surface properties of polymers and ionic liquids.

Ebrahim Norouzi[+]

Max Planck Institute, Dusseldorf, Germany
+ Presenting and corresponding author
email: ebrahim.norouzi@iwm.fraunhofer.de

APACHE APP interfaces for cultural heritage interoperable multi-scale simulation workflows

The APACHE APP offers a web interface that aims at building and executing interoperable multi-scale simulation workflows to predict the degradation of Cultural Heritage objects. Additionally, it enables controlling and monitoring the ongoing computational process and makes the results available to the APACHE decision support system that recommends possible corrective actions to be considered by curators. Here we focus on a user case for acrylic paints and demonstrate the APACHE APP and its lean interfaces, including initial integration within the European Materials Modelling Marketplace, that facilitate interoperability across the various scales and codes.

Ebrahim Norouzi (Research Participant, Male) holds a MSc degree in Materials Science and Simulation (ICAMS), from Ruhr University of Bochum, Germany. He has solid knowledge in python including various data science tools such as SQL, Machine Learning, Statistical analysis, data visualization as well as of web user interface design. He acquired a deep understanding of characterization techniques including EBSD, APT, TKD from his previous work at Max Planck institute for Iron research and has experience with cluster analysis for Big Data of APT to identify clusters of atoms at MPIE as well as FEM and Phase field simulation.

Alex Zabeo[+ # 1], Elena Semenzin[1], Giacomo Chiarot[1], Alison Heritage[2], Antonio Mirabile[3]

1 - Ca' Foscari University, Venice, Italy
2 - International centre for the study of the preservation and restoration of cultural property, Rome, Italy
3 - Atelier Mirabile, Paris, France
+ Presenting and corresponding author
email: alex.zabeo@unive.it
 # Trainer

Apache Decision Support System supporting preventive conservation actions

During this presentation the Apache Decision Support System (DSS) web application will be introduced, its main aims and functionalities will be presented as well as selected exemplificative case studies from the Apache project. The DSS is composed of two tiers of increasing detail. The first tier is an introductory wiki style guideline for generic preventive measures' application while the second tier is a detailed support system tailored to the user's institution and collected artworks.

Alex Zabeo is senior Researcher, Ph.D. in Informatics. His research activities focus on Decision analysis, Probabilistic Risk Assessment and Life Cycle Assessment. He has proven expertise in project and development of standard and Geographical Decision Support Systems (DSS) and in Multi-Criteria Decision Analysis (MCDA) - Fuzzy Logic (FL) - Value of Information (VoI) – Artificial Intelligence (AI) based assessment methodologies as well as in design and realization of studies and software related to Life Cycle Assessment (LCA) and management of complex sensors' networks and Internet of Things (IoT). He's been guiding the Decision Support area of several European and National projects.

SECTION 3:
Materials developed in the APACHE project to influence the environment

Piero Baglioni[+][#], David Chelazzi[#], Rodorico Giorgi, Marianna Mamusa, Giulia Moretti, Giovanna Poggi and Claudio Resta

Department of Chemistry and CSGI, University of Florence, Italy
+ Presenting and corresponding author
email: baglioni@csgi.unifi.it
 # Trainer

Innovative "green" gels as new pollutant absorbers in Preventive Conservation

Currently, there is a need in Preventive Conservation (PC) for practical and affordable pollutant absorbers, so as to favour the preservation of vast collections or enclosures where the use of expensive filters is not possible. The absorbers should be easy to use, renewable or easily replaceable, and made of environmentally friendly materials. Castor oil (CO)-based gels are optimal candidates to meet these requirements: CO is a "green" biopolymer that can be used to formulate gels or hybrid networks where chemical absorbers, targeted to specific VOCs, are included. The seminar will discuss recent formulations of CO gels and hybrids, which are being developed in the H2020 APACHE project (Active & Intelligent Packaging materials and display cases as a tool for preventive conservation of Cultural Heritage) as absorbers for aldehydes, acetic acid and formic acid.

Piero Baglioni is Professor of Physical Chemistry in the Department of Chemistry at the University of Florence and is a MIT affiliate. He is on the editorial/advisory boards of several international journals and a member of the scientific board of several national and international Institutions and societies. He is the author of more than 480 publications and 25 patents in the field of colloids and interfaces and a pioneer in the application of soft matter to the conservation of Cultural Heritage.

David Chelazzi received his Master's Degree in Chemistry from the University of Florence (Italy) in 2003 and went on to obtain his Ph.D. degree in Science for Cultural Heritage Conservation in 2007 under the mentorship of Piero Baglioni. He is currently a researcher at the University of Florence (Department of Chemistry and CSGI). His research interest is in the development of advanced and nanomaterials for the conservation of works of art. He is author and co-author of more than 55 papers including leading peer-reviewed international journals in the field of physical-chemistry, conservation science, and environmental science. He has been (and is) involved in European and national projects on the development of advanced materials and solutions for the preservation of cultural heritage (FP7 NANOFORART 2011-2014, POR FESR 2007 -02103 TeCon@BC 2011-2012, H2020 NANORESTART 2015-2018, H2020 APACHE 2019-ongoing)

Gabriella Di Carlo, Elena Messina, Maria Paola Staccioli[+], Monica Albini, Marianna Pascucci, Cristina Riccucci, Gabriel M. Ingo

Institute for the Study of Nanostructured Materials (ISMN), National Research Council (CNR), Rome, Italy
+ Presenting and corresponding author
email: mariapaola.staccioli@ismn.cnr.it

Multifunctional materials based on chitosan for the removal of degrading species in museum storage/display environments

The ability of chitosan-based materials to selectively interact with degrading species (such as organic acids and aldehydes), dangerous for the cultural heritage objects, can be used to create a stable micro-environment in storage and display cases. The performance of these materials can be optimized by controlling their chemical functionalities and by introducing appropriate fillers. This issue is addressed within the EU APACHE project aimed at the development of new solutions for the preventive conservation of cultural heritage.

Gabriella Di Carlo, PhD in Chemistry, is Senior Researcher at ISMN-CNR in Rome. Her main research interests include the development of innovative materials and technologies for the sustainable conservation and fruition of Cultural Heritage. She works on surface studies at micro and nanoscale with multianalytical approaches and on the synthesis and validation of smart nanostructured materials. Her activities are mainly conducted within national and international projects (as ongoing H2020 InnovaConcrete and Apache projects). She has co-authored about 75 publications on international ISI journals receiving more than 3300 citations and with an H index of 28.

Panagiotis Goulis[+], Andronikos Balaskas, Dimitrios Dragatogiannis, Costas A. Charitidis

National Technical University of Athens (NTUA), Athens, Greece
+ Presenting and corresponding author
email: pgoulis@chemeng.ntua.gr

Humidity sorption study using PVA membranes and Super Absorbent Polymers

The aim of this study is to examine the conditions for a successful integration of relative humidity and temperature regulators as well as their mode of action in enclosures for cultural heritage inside storage boxes. Super absorbent polymers are partially cross-linked, three-dimensional polymer networks that can absorb and retain liquid. Polyvinyl alcohol based membranes demonstrate moisture sorption properties with minimal ecological impact. In this work, these two materials are tested, concerning their sorption properties under controlled conditions, in order to investigate their effectiveness in protecting sensitive items from humidity over the course of time.

Dr.Panagiotis Goulis is a distinguished Chemist with a Master's degree in Polymer Science and a Ph.D. in Materials Science. He is a certified English, German and French speaker. His research interests focus on the organic and inorganic synthesis, as well as characterization methods. Moreover, he has dealt with polymeric precursors, polymerization of monomers, polymer extrusion, as well as mechanical properties characterization. He is also involved in the synthesis of silicate, magnetic nanoparticles, super absorbent polymers and core-shell copolymers. He has published 10 research papers in reputable journals, while part of his research has been presented at international and national conferences.

Maria Kostidi[12], George Gorgolis[2] and Costas Galiotis[12+]

1 - University of Patras, Patras, Greece
2 - Foundation for Research and Technology – Institute of Chemical Engineering Sciences, Greece
+ Presenting and corresponding author
email: c.galiotis@iceht.forth.gr

Roll-to-roll graphene transfer as an effective tool for the protection of artworks

All art materials are generally prone to degradation. In particular, the 20th century cultural heritage shows short lifetime expectancy due to the introduction of novel materials and techniques. Graphene-related materials have been found to provide considerable ultraviolet shielding as coatings, while a single layer CVD graphene absorbs up to 3 times more in the UV region (190-400 nm), than in the visible range. Additionally, chemical molecules such as water or oxygen cannot penetrate a continuous graphene membrane providing the ultimate shield against degradation. An invisible veil of graphene could provide protection for old and contemporary paintings against all these factors.

Costas Galiotis is a Professor at the Chemical Engineering Department of University of Patras and Collaborating Faculty Member of the Institute of Chemical Engineering Sciences of FORTH (FORTH/ ICE-HT). He graduated from the University of Athens in 1977 and received his PhD from the University of London (Queen Mary College) in 1981. From 1985 till 1997 he served as a member of professorial staff at Queen Mary University of London. He moved to Greece in 1997 as a Research Director FORTH and was appointed Professor at the University of Patras in 2002. From 2007 till 2013 he acted as the Director of FORTH/ ICE-HT. Since 2017 he serves as the Director of the Physical Sciences programme of the HFRI (Greece) and in the Executive Board of the European Graphene Flagship. His current research interests are in the areas of nano and micro-mechanics, graphene and also preventive conservation of art objects. He has published approx. 300 journal papers, book chapters and reviews which have been cited over 18000 times (GS). He is the Editor-in-Chief "Graphene Technology" (Springer-Nature) and Editorial Board Member of "Scientific Reports" (Nature). He is a fellow of the European Academy of Sciences and of the Institute of Materials, Minerals and Mining (IOM3).

SECTION 4:

Sensors and solutions to describe and interact
with the environment

Marco Girolami[+] on behalf of DiaTHEMA Lab of CNR-ISM, CNR-ISMN, and Ionvac Process Srl

National Research Council of Italy, Institute of Structure of Matter, DiaTHEMA Lab
+ Presenting and corresponding author
email: marco.girolami@ism.cnr.it

Sensitive and selective electrochemical sensors for monitoring the atmosphere of display cases and crates in museums

The development of low-cost sensitive and selective sensors for correctly monitoring the atmosphere immersing artistic and historic artifacts is one of the main aim of the frontier technology applied to cultural heritage. The presentation will report the past and the present state-of-the-art technology, so to successively discuss the technology and results achieved under the APACHE project.

Marco Girolami received the Ph.D. degree in Electronic Engineering in 2011 from Università Roma Tre (Italy). From 2009 to 2014 he was assistant professor of Microelectronic Technologies with the Faculty of Engineering of Università Roma Tre. Since 2012, he has been a researcher with CNR-ISM (Consiglio Nazionale delle Ricerche, Istituto di Struttura della Materia, Italy). His current research interests include the development of detectors for ionizing radiation, the design of innovative chemical sensors for volatile organic compounds, and the study of laser-induced nanostructuring techniques for energy, photonics, and life science. He is author of about 80 publications in ISI-listed journals.

Daniela Iacopino[1+], Eoghan Vaughan[1], Alessandra Imbrogno[1], Cathal Larrigy[1], Aidan J. Quinn[1], Chiara Santillo[2], Marino Lavorgna[2], George Paterakis[3], George Gorgolis[3], Costas Galiotis[3]

1 – Tyndall National Institute, Cork, Ireland
2 – Istituto per i Polimeri, Compositi e Biomateriali-CNR, Portici, Naples, Italy
3 - Foundation for Research and Technology – Institute of Chemical Engineering Sciences, Patras, Greece
+ Presenting and corresponding author
email: daniela.iacopino@tyndall.ie

Flexible and bendable sensor platforms for monitoring of heritage artworks

Laser Induced Graphene (LIG) is a porous and conductive material generated by direct laser writing of flexible polyimide tapes. Due to its low cost, high speed of production and high throughput, the technique is ideal for generation of low cost electrode sensors for heritage applications. In this talk we will explore the use of LIG electrodes has electrochemical sensors and humidity sensors. Furthermore, we will explore the generation of LIG electrodes from natural polymer sources alternative to polyimide, which will open the way to fabrication of the new generation green sensors for monitoring of heritage artworks.

Dr Daniela Iacopino obtained her master degree in Chemistry from Universitá di Pavia in 1995 and a PhD in Chemistry from Universitá di Modena in 2000 (Italy). Between 2000 and 2002 she worked as postdoctoral fellow in the Department of Chemistry of University College Dublin. In 2006 she became a senior researcher in the Nanotechnology group of the Tyndall National Institute where she now leads the "Integrated Nanomaterials" team. Her research interest focus on synthesis of nanomaterials and fabrication of electrode materials for sensing applications. Daniela is a Funded Investigator in the SFI national centres of excellence CONNECT and VistaMilk.

Dinesh R. Gawade[1+#], John Buckley[1], Brendan O'Flynn[1], Daniela Iacopino[1], Steffen Ziemann[2] and Manfred Anders[2]

1 - Tyndall National Institute, University College Cork, Ireland
2 - ZFB Zentrum für Bucherhaltung GmbH, Leipzig, Germany
+ Presenting and corresponding author
email: dinesh.gawade@tyndall.ie
 # Trainer

A battery-less NFC sensor transponder for museum artefact monitoring

This presentation presents a recently developed, low-cost, battery-less Near-Field Communication (NFC) sensor transponder for the museum artifacts monitoring of Cultural Heritage objects as part of the APACHE project. The developed sensor transponder combines a unique combination of packaging materials and NFC technology to enable a low-cost preventive conservation solution that is practical to implement, something that is not commercially available at the present time. The developed transponder wirelessly monitors temperature and humidity conditions inside cardboard artefact storage boxes and only requires a smartphone to operate. The transponder has been specifically designed with low cost in mind. The presented wireless sensor design meets key requirements for museum archive monitoring applications such as a low-cost implementation (5 in quantities of 10k), near-field communication range (4 cm), and shelf life (5 Years).

Dinesh R. Gawade received a Bachelor's of Technology Degree in 2016 from the Department of Technology, Shivaji University, India in Electronics and Communication Technology. After graduation, he worked in the electronics industry for 2 years as a hardware design engineer from 2016 until 2018. He then worked as an academic researcher at the Indian Institute of Technology Mandi (IITM), India as a project engineer (Hardware design) before joining Tyndall National Institute in 2018. Presently in Tyndall, Dinesh is pursuing a MEngSc degree within the Antenna and RF Design team in the WSN group. He is a member of T-UCC research team, who developed a battery-less sensor transponder for the APACHE project.

Manfred Anders[+][#] and Steffen Ziemann[+][#]

ZFB Zentrum für Bucherhaltung GmbH, Leipzig, Germany
+ Presenting and corresponding authors
email: anders@zfb.com and ziemann@zfb.com
 # Trainer

Converting conventional passive into novel active archive boxes

As one of the processing enterprises among the APACHE partners, ZFB deals with customer-oriented solutions for conservation of cultural heritage as well as the conception, development, manufacturing and distribution of archive boxes made of corrugated board. Contributing to the projects' objectives of creating active & intelligent storage enclosures, ZFB's research department strongly focuses on the creation and preservation of desirable interior climate conditions via optimizing conventional corrugated board enclosures. Constant knowledge transfer with sensor developers additionally promotes a user-friendly utilization of wireless sensing devices in the final application. To outline the process of converting conventional passive into novel active archive boxes, the main topics highlighted in ZFB's presentation will address improved box constructions and materials, an application-driven evaluation of novel T/RH/VOC regulators and intelligent measures for their integration.

Manfred Anders is specialist for paper-, cellulose- and textile chemistry. He received his PhD "Analysis of paper ageing and preservation of damaged papers by deacidification and consolidation" at the University of Stuttgart in 2000, held teaching assignments in Reutlingen and Hildesheim and has been a member of the IADA board from 1999-2007. Since 2002 he works as CEO of ZFB Zentrum für Bucherhaltung GmbH.

After studying chemistry at the Friedrich-Schiller-University Jena and receiving his PhD in metal-organic & inorganic chemistry, Steffen Ziemann joined ZFB Zentrum für Bucherhaltung GmbH 2019, where he works as researcher for preventive-conservational product innovation.

Josep Grau-Bové[+][#]
and Himantha Cooray[+][#]

University College London, United Kingdom
+ Presenting and corresponding authors
email: josep.grau.bove@ucl.ac.uk and h.cooray@ucl.ac.uk
 # Trainer

Josep Grau-Bové is an expert in heritage microenvironments and their effect on historic collections. He research focuses on using computational tools to improve preventive conservation.

Himantha Cooray is specialised in computational modelling and applied mathematics related to fluid mechanics. He currently develops models to understand the microclimate in museum storage boxes and display cases.

Trainings

Manfred Anders and Steffen Ziemann: Integration and practicability of regulators and sensing devices in archive boxes

Examples of customized storage solutions for special applications in archives / museums will be presented.

Improved box constructions / materials will be shown.

The utilization of an integrated T/RH sensor transponder can be tested.

Modular combinability of T/RH/VOC absorbents or regulators with the storage enclosures will be demonstrated and can be tested.

Dinesh R. Gawade: A battery-less NFC sensor transponder for museum artifact monitoring. Demonstration

Overview of battery less NFC sensors transponder hardware and functionalities.

Working principle and demonstration of sensor transponder, outsid cardboard box.

Museum archived artifact monitoring concept demonstration using battery-less NFC sensor transponder.

Hands-on practice with museum archived artifacts monitoring using a battery-less NFC sensor transponder.

Piero Baglioni and David Chelazzi: Innovative "green" gels as new pollutant absorbers in Preventive Conservation

Introduction to organogels.

Demonstration of gels features and handling.

Criteria for the gels selection according to the VOC/VOCS to be removed.

How to apply gels.

Alex Zabeo: APACHE Decision Support System application in real collections case studies

Log in and user preferences management.

Navigating tier 1 generic preventive measures information.

Registering a new institution in tier 2.

Adding locations, rooms and artworks.

Navigating through specific preventive measures' suggestions.

Reading data from sensors and managing harmful conditions.

Josep Grau-Bove and Himantha Cooray: Using a decision making-tool to select the best storage enclosure.

This activity is a demonstration of a digital tool to help decision-makers choose the best enclosure given a certain environment and preservation priorities.

Participants will learn how to use the digital tool. They will also learn are the main parameters that define the environment within an enclosure.

Users will be able to upload real environmental data provided by the trainers and explore in the computer how different boxes will create different microclimates.

The tool includes parameters such as buffering materials, wall material, thickness of the walls, and ventilation holes in the box.

PROJECT TITLE: Active & intelligent PAckaging materials
and display cases as a tool for preventive conservation of
Cultural Heritage.

ACRONYM: APACHE

STARTING DATE: 01 January 2019

DURATION: 42 months

TOPIC: NMBP-33-2018 | Innovative and affordable solutions
for the preventive conservation of cultural heritage (IA)

EU CONTRIBUTION: 6,837,732.75 euro

APACHE

*Active & intelligent PAckaging materials
and display cases as a tool for preventive
conservation of Cultural HEritage.*

ORGANISATION

Antonio Mirabile - APACHE Project
Marco Nervo, Selena Viel and Tiziana Cavaleri
Fondazione CCR "La Venaria Reale"