Innovative packaging solutions for storage and conservation of 20th century cultural heritage of artefacts based on cellulose derivatives

Newsletter | Issue n. 3 | March 2021

EDITORIAL

KETs to preserve the Cultural Heritage
by AIMPLAS (Project coordinator)

In recent years, we are witnessing different research initiatives to preserve different nature of cultural heritage such as painting, posters, photography and films, among other artefacts, which are based on the use of the **Key Enabling Technologies** (KETs) such as **Nanotechnology** and **ICT**.

Both have a lot to contribute to the field of conservation of artistic and cultural heritage, as per example:

- at the level of interaction with the object, slowing down and delaying the aging process, for example the case of scavengers based on different **nanomaterials and chemical compounds**,
- in the monitoring and prediction of the degradation processes, thanks to the development and **integration of sensors and wireless data communication** that facilitates and automates the real time monitoring of the artistic object status,
- through the development of **predictive mathematical models** capable to foresee the artistic object degradation based on a set of measured parameters and environment conditions, allowing to take decisions and concrete actions based on the status of the artefact.

An evidence of this is the celebration of the 1st workshop of the NEMOSINE project last 18th of February, in collaboration with three other European research projects in the field of preservation of cultural heritage such as APACHE, Collection Care and SensMat. The workshop made it possible to share the main lines of research and results that are being obtained in each of the projects. This event is allowing to lay the foundations of a collaboration among the different entities, that participate in these projects, creating synergy to promote the progress in research and development of advanced solutions aimed to the preservation of cultural heritage.

We hope that the contents published in this NEMOSINE newsletter, in which we collect the progress that are being made within the project framework, are on your interest.

Contents

NEMOSINE in brief

NEMOSINE Round Robin Test: assessing the performance of acetic acid adsorbers at the Deutsches Filminstitut & Filmmuseum

by Aida Suárez Trabanco
from Deutsches Filminstitut & Filmmuseum (DFF)

In the current stage of the NEMOSINE project, a so-called Round Robin Test is being performed by the archive partners. The Centre National de la Recherche Scientifique (CNRS, France) developed a testing procedure which is now being carried out on the premises of Deutsches Filminstitut & Filmmuseum (Germany), Institut Valencià de Cultura (Spain) and Österreichische Akademie der Wissenschaften (Austria). The aim of the Round Robin is to assess the efficiency of the acetic acid sorbents which are considered to be used in the NEMOSINE smart packages.

Firstly, each film archive selected from their collections five pairs of 35mm cellulose acetate reels with similar characteristics: length, type of material, age, and A-D strip acidity level. This was necessary in order to compare the performance of two types of adsorbers, MOFs (Metal Organic Frameworks) and zeolites, in capturing the harmful acetic acid outgassing from inside the film cans.

Before placing any sorbent in the cans, we measured the initial acidity level by introducing a Gastec passive tube for acetic acid and sealed the package with aluminium tape. After an exposure time of several hours, we removed the tube and checked the graduated colour shift -from purple into yellow- quantifying the acidity concentration.

After this preliminary measuring, we placed a plastic receptacle containing either MOFs or zeolites shaped into pellets in the center of each reel. A data-logger was included as well to monitor the humidity and temperature; this information can later be retrieved and, if needed, the adsorbed volatile organic compounds analysed.

The sorbent containers will be kept inside the film packages during the remaining time of the RR. After two weeks the acidity is measured again with passive tubes, and once more after six weeks, in an attempt to evaluate the quantity of acetic acid adsorption over a period of time. All data are entered into a sheet for subsequent conclusions and calculations.

The results of the Round Robin Test will be valuable for the project because they will demonstrate if the MOFs are an interesting option to be integrated in the NEMOSINE smart packages. Furthermore, although the RR is being performed independently in the three film archives, the exchange of first-hand experiences is generating a conversation between these institutions in a manner that enriches the whole process.
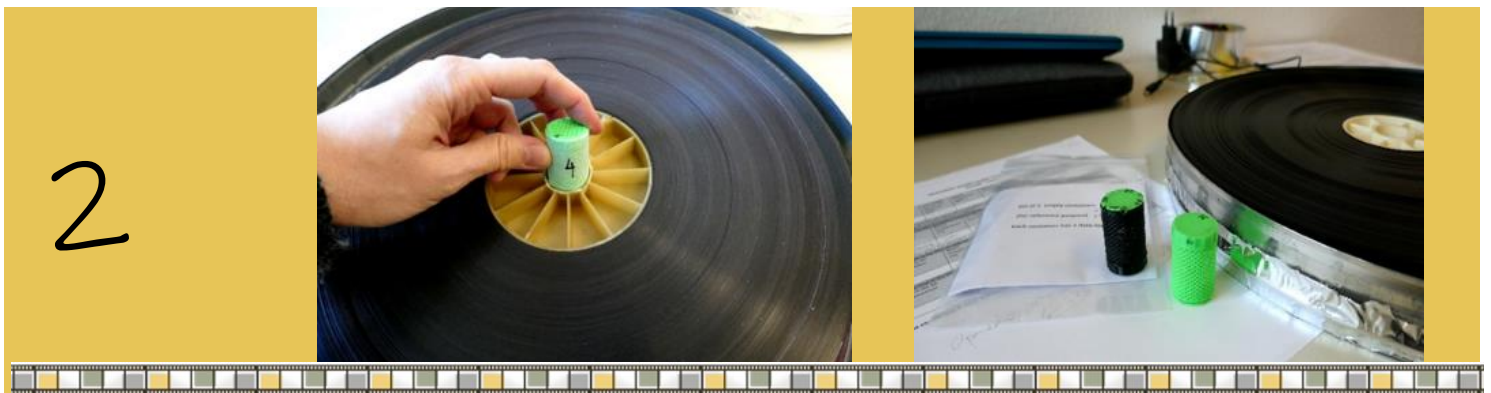
The following images show some of the actions executed during the Round Robin Test:

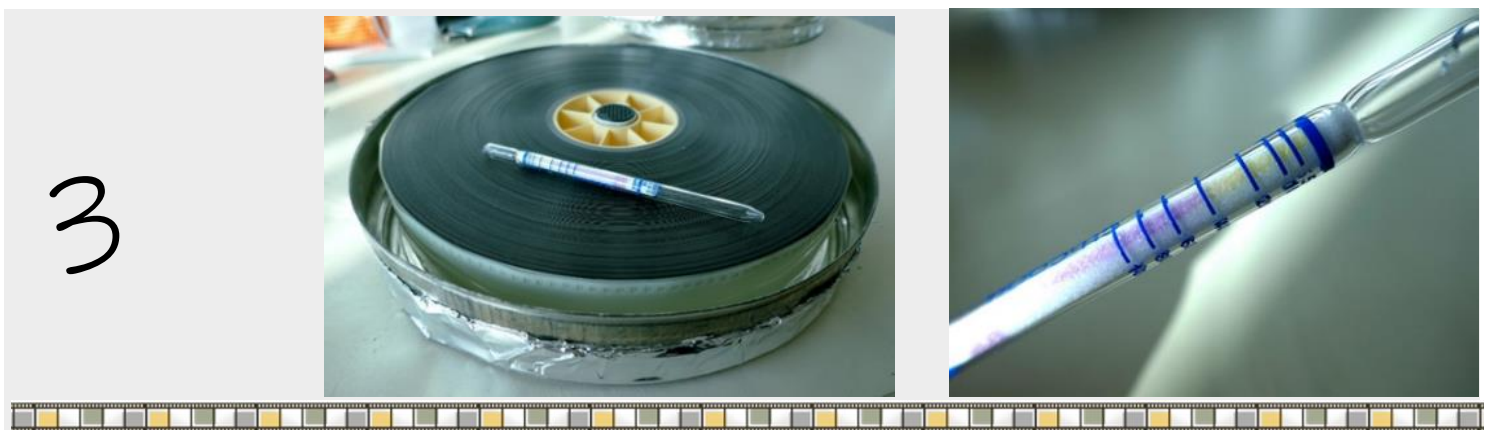NEMOSINE Round Robin Test: at the Deutsches Filminstitut & Filmmuseum

Search and selection of five pairs of films

1

Introducing the adsorbers after the first acidity measurement

2

Measuring the acidity level using Gastec passive tubes

3

R&D Innovation for Cultural Heritage preservation
NEMOSINE first technical collaborative workshop

by PNO Innovation

Last 18th February, was successfully held online the first NEMOSINE technical workshop, in collaboration with our Horizon 2020 sisters' projects: APACHE, CollectionCare and SensMat.

The workshop started with a presentation of the ECHOES Cluster (www.echc.eu) describing the role that the cluster plays supporting the scientific community to create network with different expertise in Cultural Heritage (CH) conservation and, introducing the funding opportunities in the new programme Horizon Europe to promote the research and collaboration actions for CH.

The **technical core** of the online event was focused on two **common research topics** of the projects, mainly:

Preventive and protective interventions

- Multi-material degradation models for the preventive conservation of cultural heritage, by CollectionCare,
- Multi-scale modelling to allow predictions about CH degradation, by APACHE,
- Protective systems based on Acetic Acid absorbers and curative system based on antifungals, by NEMOSINE, and

Image of the NEMOSINE 1st technical workshop

- Knowledge management and decision-making tools for preventive conservation, by SensMat.

Sensoring

- A decision-making system for preventive conservation based on wireless sensorization of environmental parameters, by CollectionCare,
- Gas detection sensors to monitoring AA, O2 & NO, multi-scale modelling to correlate degradation & sensors signals, by NEMOSINE,
- Wireless sensoring systems for monitoring VOCs, pollutants, and humidity, by APACHE, and
- New innovative corrosiveness sensors for sensors network, by SensMat.

The workshop, hosted by AIMPLAS (NEMOSINE project coordinator), has been a good occasion for paving the way for new collaborations' opportunities and to create synergies with the ongoing activities and expected results of the four projects.

The event counted with the attendance of more than 100 professionals with the common interest of contributing to cultural heritage preservation.

More information about the sisters' projects is available in the following links. These projects have received funding from H2020 research and innovation programme.
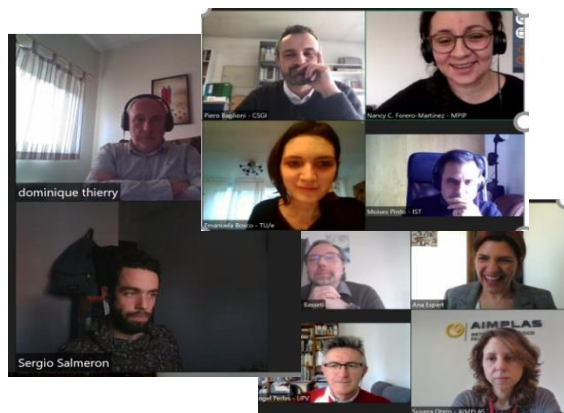
APACHE - GA nº 814496
https://www.apacheproject.eu

COLLECTIONCARE - GA nº 814624
https://www.collectioncare.eu

SENSMAT - GA nº 814596
https://www.sensmat.eu

First-Principles Model to Evaluate Quantitatively the Long-Life Behavior of Cellulose Acetate Polymers

By Instituto Superior Tecnico, Universidade de Lisboa (IST - Ulisboa)

A paper, prepared by IST- Ulisboa, in collaboration with the New University of Lisbon, has been recently published in ACS Omega journal. The article reports on the developed model for the degradation of the pure polymer within the NEMOSINE framework. The authors(*) have shared this summary to introduce the contents to our readers and to invite to read the full version by visiting this link: https://pubs.acs.org/doi/pdf/10.1021/acsomega.0c05438

IST-Ulisboa, in the framework of NEMOSINE, has led a study to quantitatively determine the degradation kinetics of cellulose acetate polymer. The approach successfully couples quantum chemical calculations, that were performed to determine the reactions energetics from first principles, with the transition state theory to evaluate the long-life stability of the polymer.

This study provides insights on the degradation mechanisms as well as the role of Acetic Acid (AA) as a reaction product and catalyst. For the first time the AA volatility was accounted for, upon measuring the Henry's constant of AA on cellulose acetate polymer and considering the mass balance equation for the sorbed/gas phases equilibria. Unlike all previous studies, the developed model reports on the explicit dependence of the degradation kinetics on the environmental conditions namely: temperature, relative humidity, pH of the medium, the initial concentration of AA in the atmosphere, the mass of the polymer and the volume of the box. The developed model was validated upon comparison with experimental results from accelerated aging experiments performed by New University of Lisbon partner (FCT-NOVA).

IST-ULisboa considers the developed model as the fundamental building block towards understanding/predicting the behavior of CA in all CA-polymer-integrated applications of real polymer blends that are more complex. They are now collaborating closely with 5 partners within the NEMOSINE consortium and working on adapting the developed model to the case of historical films based on CA polymer. Having the information on how historical films are degrading as function of environmental conditions enables designing a personalized solution and planning conservation actions.

(*) Authors: Abeer Al Mohtar, Sofia Nunes, Joana Silva, Ana Maria Ramos, Joao Lopes, and Moisés L. Pinto
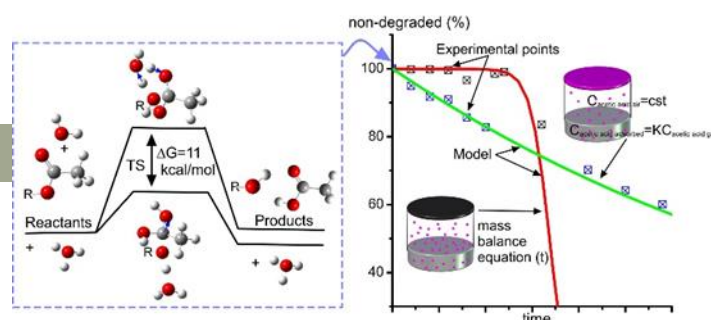
Highlights

NEMOSINE:

results of 2nd review meeting with the EC

Last 8th of March, NEMOSINE consortium had the second review meeting on project's progress with the European Commission (EC).

The review was based on the results reached in the 18 months of activities and the milestones achieved by the consortium.

It makes us feel proud that the project officer put value in the effort of the NEMOSINE's beneficiaries despite the challenging situation that the COVID-19 pandemic is having on the development of the scientific and technical work.

We look forward to the last year of the project with renovated strength and commitment to reach the final results and to demonstrate the functionalities and benefits of the **NEMOSINE innovative packaging solutions** for storage and conservation of artefacts based on cellulose derivative.
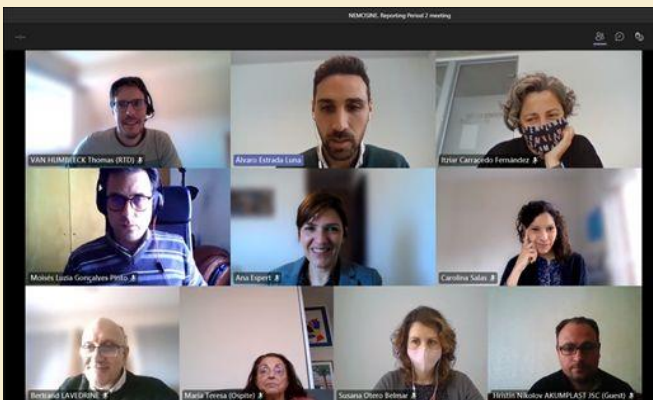
Picture of the 2nd review meeting:
NEMOSINE project officer and WP leaders

FORTHCOMING EVENTS

Forum Teratec

June 22-24, 2021
Place: Digital event
https://teratec.eu/gb/

The Forum Teratec aims to provide its audience with a vision of innovative technologies around Simulation, HPC, Big Data and AI, as well as trends for a large number of industrial fields in need to address demands for "personalized" experiences.

APACHE: first public training

September 2-3, 2021
Place: Musée du quai Branly Jacques Chirac
https://www.apacheproject.eu/

The training aims to explore the APACHE's project activities. It seeks to transfer 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.

CollectionCare Conference:
New Challenges in Preventive Conservation, Predictive Analysis and Environmental Monitoring

December 1-3, 2021
Place: Universidad Politécnica de Valencia (Valencia, Spain)
https://www.collectioncare.eu/conference

The conference aims to be a forum to exchange highly specialized research and the latest technological advances in the study of the behavior and aging of cultural heritage materials, environmental monitoring, and the design of preventive conservation strategies in collections.