ADAMO Technologies of Analysis,

Diagnostics and Monitoring for the preservation and restoration of

Cultural Heritage

A Research project in the Center of Excellence of the District of Technologies for Culture of Lazio Region

Participants: ENEA, INFN, CNR, Uni. Rome Sapienza, Uni. Rome Tor Vergata, Uni. Roma Tre, Uni. Tuscia (Viterbo)

Project objectives

- 1. Technology transfer on relevant themes
- 2. Services to enterprises based on facilities offered by DTC partners
- 3. Demonstrations in selected cases studies
- 4. Development of prototypes and test of innovative products



ADAMO

TECNOLOGIE DI ANALISI, DIAGNOSTICA E MONITORAGGIO PER LA CONSERVAZIONE E IL RESTAURO DI BENI CULTURALI

Oct. 2, 2018 – Jan 1, 2020 Progettoadamo.enea.it

Integrate applications of remote, in-situ and laboratory instruments for spectroscopic diagnostics



Partners and Role



WP0	Management	Roberta Fantoni ENEA	
WP1	Construction, consolidation and sharing	Maria Prezioso RM2	
WP2	Analyses and diagnostics by chemico- physical technologies	Maria Antonietta Ricci RM3	
WP3	Analysis and diagnostic by large scale facilities	Mariangela Cestelli Guidl INFN	laboratory measurements
WP4	In-situ and remote analysis and diagnostics	Mauro Missori CNR	
WP5	Analysis of materials for conservation and restoration, and treatments evaluation	Claudia Pelosi TUS	In-situ measurements
WP6	Advanced systems for environmental monitoring	Marialaura Santarelli RM1	
WP7	Bio-archaeology, anthropology and environmental biology	Laura Sadori RM1	

Significant activities involve nanotechnologies





Contest analysis and choice of demonstration sites







Material characterization – a case study on fresco fragments from «Villa della Piscina»

Frescoes' fragments from «Villa della Piscina - Centocelle Park» (Roma).

The site choice - objectives and achievements:

- Relevant to Park fruition, the ruins are now buried but frescoes' fragments are kept in a repository, virtual fruition of reconstructed painted wall would be possible.
- Fragments come from different walls, the problem is to support their assignment to each wall.
- Pigment palette of a wall from the 2nd half of Ist century a.D., by means of Raman spectroscopy, LIF, LIBS e XRF (WP2), FT-IR and PIXE (WP3) on 34 samples
- Laboratory measurements on mortars XRD, analyses with micro-sampling (WP5)
- Geographical origin and possible dating of materials
- Realization technologies (optical microscopy and SEM, stratigraphy) – ancient nanotechnology!
- Assignment of 11 fragments to a wall on the basis of in-situ UVvis reflectance measurements (WP4)

Partecipants: UniRoma3, INFN, ENEA, CNR-ISC



Cinnabar, earths (hematite and magnetite, goethite, celadonite), malachite, Egyptian blue, calcite e dolomite, smoke black



FT-IR in situ by INFN-LNF

CENTRO DI ECCELLENZA

Advanced nanoscale correlative mechanical and chemical probing



Materials Science & Technologu

DIPARTIMENTO DI ECCELLENZA

Counteract bio-degrading with test of biocydes by LIF- frescoes in «Catacombe dei SS Pietro e Marcellino, Torpignattara» -

The site choice – objectives [WP6, WP7]:

- An important catacomb with painted rooms, nearby Centocelle Park.
- Interest to preventive conservation of recently restored frescoes.
- On going parallel physiologic characterization of bio-deteriogen micro-organisms formerly isolated in «Catacombe di San Callisto» [UniRM1].
- Essential oils vs commercial products as biocide.



Major achievements in laboratory tests from a fresco fragment-

- characterization of microbe communities present inside the catacombs, in order to compare with those ones detected in different hypogea around Roma area [UniRM2];
- definition and test of new strategy to reduce the phototrophic growth on frescoes inside the considered Catacombs by means of essential oils, which demonstrated biocide capacity [UniRM2];
- evaluation by means of laser induced fluorescence (LIF) and reflectance of both chemical composition and color changes onto the painted surface due to the treatment [ENEA].



Frescoes in Priscilla's Catacombs in Rome Laser scanners for biodegradation analysis



P2 - subarea where the P4 - far away from the biomass is less dense

bio-deterioration is not evident naked-eye biomass area

Contribution to bio-attack monitoring by means of biofilm area's circumscription by the post processing analysis of the RGB-ITR 3D model







P1 - intense emission band at 340 nm, identifying the biological material present in that area

P2 - the emission in intensity band at 340 decreases and a large band at 500 nm appears P3 - Band at 340 nm still present, low intensity, and band at 500 nm increased in intensity P4 - Band at 500 nm is the only band present

Persistence of the fluorescence band at 340 nm in P3 possibility of early detection by LIF of areas attacked by microorganisms not visible in this stage



New successive colonization of other areas is visible 4 and 8 months after the first observation, due to spread of microorganisms

Laboratory characterization of stone samples from the garden of «Villa Mondragone at Monte Porzio Catone»



The site choice:

- A Renaissance Villa, built on a former Roman Villa, a local tuff stone «Sperona» is used on outer walls and in the garden,
- It includes gardens with fountains and mosaics showing important physicochemical and biologic degradation;
- Project objectives include the development and test of protective materials (WP5) and diagnostic and contrast to bio-degradation (WP7)

Laboratory measurements are on going at UniTUS and ENEA for WP5 on lapideous material from the garden, at UniRM1 and UniRM3 to check biodegradation on sample from the fountains [WP7].

Experiments on lapideous conservation involve the application of consolidants with current products (polymers, siloxanes) as commercially sold and after addition of innovative components (e.g. nano-powders).





Environmental monitoring by FBG sensors on the «Aurelian walls of Rome»

ENEA settled a demonstration site of sensors based on fiber optics with Bragg Gratings (FBG) for monitoring structural data and environmental parameters at the L3 tower of **«Aurelian Wall»** near Saint Sebastian Gate. Periodic demonstration campaigns are ongoing with continuous data acquisition for at least one month, in order to ascertain the effect of rain waters on different types of wall materials (stones, brick, etc.).





Time History of continuous acquisition for 37days on the Est wall. Left plot: crack opening correlation with temperature. Right plot: crack opening correlation with relative humidity.

ENEL (





Where Nanotechnologies are most involved in ADAMO?

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CENTRO DI ECCELLENZA

T2.3 – Advanced microscopy and nanoengineering [UniRM1,UniRM3]

T5.3 – Characterization and validation of nanostructured materials for restoration [UniRM1, UniRM3]

<u> T6.5 – FBS sensors on monuments[ENEA]</u>

<u>T6.6 – Nano-sized sensors for air quality</u> [UniRM3, UniRM1, CNR]

<u>Alternative use of essential oils to nano-based</u> materials as biocide in hypogea (T5.3, T6.4, T7.3)