Ten Projects
Horizon 2020 for Cultural Heritage
Pre-Kick Off Meeting

NATECH

Project

Second draft, March, 2015

A.I.C. – Associazione Investire in Cultura

Rome, March, 2015

Publishing coordination, revision and realization: Angelo Ferrari - CNR, Inst. of Chemical Methodologies, Italy;
Digital Editing and Data Processing: Stefano Tardiola and Gianni Pingue - CNR, Inst. of Chemical Methodologies, Italy;
Secretariat: Enza Sirugo - CNR, Inst. of Chemical Methodologies, Italy; Manuela Manfredi, A.I.C. Secretariat, Italy.

B - TECHNICAL ANNEX

COVER PAGE

Title of Proposal: ***"Nanotechnologies: Innovation for Cultural Heritage"***

Acronym: NATECH

List of Participants:

Participant No *	Participant organisation name	Country
1	X	X
2	Y	Y
3	Z	Z
4	W	W
5	K	K
6	K	K
7	K	K
8	K	K
9	K	K
10	S	S
11	L	L
12	A	A
13	O	O.

Table of Contents

1 – Excellence
1.1 Objectives
1.2 - Relation to the work programme
1.3 -Concept and approach
1.4 - Ambition

2 - Impact
2.1 – Expected impacts
2.2 – Measures to maximize impact

3 - Implementation
3.1 – Work plan, work packages, deliverables and milestones
Table 3.1a: Work package WP1 description
Table 3.1a: Work package WP2 description
Table 3.1a: Work package WP3 description
Table 3.1a: Work package WP4 description
Table 3.1a: Work package WP5 description
Table 3.1b – List of Work packages
Table 3.1c – List of Deliverables

3.2 – Management structure and procedures
Table 3.2a – List of milestones
Table 3.2b – Critical risks for implementation

3.3 - Consortium as a whole

3.4 – Resources to be committed
Table 3.4a – Summary of staff effort
Table 3.4b – "Other direct cost" items

4 – Members of the Consortium
4.1 – Participants
4.2 – Third parties involved in the Project

5 – Ethics and Security
5.1 – Ethics
5.2 – Security

NATECH

"Nanotechnologies: Innovation for Cultural Heritage"

1 – Excellence

1.1 – Objectives

"The exploitation of nanotechnology for the safeguard and conservation of Cultural Heritage is rather recent and deals with innovative materials to be used for the diagnostics, the restoration and conservation of many artifacts, as wall paintings, archaeological objects, buildings easel paintings, wood, ancient papers and manuscripts, concrete, steels, polymers and related composites, etc.

This Project deals with the following activities:

1–Diagnostics by nano markers

High performance new facilities and nondestructive and/or nano-invasive methods to be used especially in situ (spectroscopic, spectrometric, diffractometric, electron microscopy techniques) capable to identify qualitatively and quantitatively at nanometric or molecular level the morphology, structure and composition of different materials, together with their compatibility with the substrate, their stability and reactivity, the mechanical and thermal properties, etc. and to detect suitable nano or molecular deterioration markers to be used in fast and inexpensive determination of the state of conservation and of incipient decay processes.

2 –Restoration by nano-systems

- clearing procedures based on micelles and nano-emulsions or other nano-systems as nano-structural gels.
- calcium alkoxides: tailored nano-products as consolidants and coatings, especially for the conservation of historical buildings. Some examples are nano-dispersions as $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$, $Sr(OH)_2$), as consolidants of suitable carbonated substrates (marbles, etc.).
- Silane/syloxane, acrylic and silica nano-dispersions, using inorganic, organic and mixed consolidant products.
- Nano-silica injected in the substrate of wall paintings. This action could be alternative to nano-lime actually used while zirconia and/or alumina nanoparticles can improve mechanical resistance of artwork surface layer and go deeper inside the body of the piece.
- polymeric nanosilicate nanocomposite (nanofillers into a polymeric matrix)
- photocatalytic cement-based materials
- bio deterioration restoration based or nano biocatalysts
- functionalized alkoxy silane for deacidification and consolidation of paper..
- carbon nanotubes for mechanical improvement of timber structures.

3 – Conservation by nano – systems

· Organic resins used in latest fifty years demonstrated poor time and weather resistance. In some cases they worsened the appearance and the conditions of the artwork. The use of inorganic coating can override these problems, due to their long term stability; moreover, it can improve the "self-conservation" of the artwork, for example in the case of titanium dioxide, that gives self-cleaning (super-hydrophilicity) and antimicrobial effect to the treated surface.

1.2 – Relation to the Work programme

The work programme topic NATECH relates to be decided

a) **Call Specific Challenge:**

b) **Call Scope:**

c) **Call Expected impact:**

d) **Call Types of action:**

Code 1 (to be written once all Work packages are ready)

1.3 – Concept and approach

Code 2 (to be written once all Work packages are ready)
(Describe the overall project starting from the activities of WP2, WP3, and WP4: their approach, methodology, etc. and any national or international research linked to this project).

1.4 Ambition

Code 3 (to be written once all Work packages are ready)
(Describe for the overall Project, i.e. for the activities reported in WP2, WP3, and WP4:
1 - the state-of-the-art
2 – the progress beyond the state-of-the-art
3 – the literature concerning the previous points)

2 – Impact

2.1 –Expected impacts

Code 4 (to be written once all Work packages are ready)

(Describe how a lasting impact of the Project will be ensured by the following strategic Project choices):

………………………………………………...

(In particular, describe the following Project outcomes that will become available in a practical use):

………………………………………………...

2.2 –Measures to maximize impact

Code 5 (to be written once all Work packages are ready)

a) Dissemination and exploitation of results

Preparation of a draft plan for dissemination of project results
All Partners will prepare items for publication (scientific papers, conference abstracts, website updates, etc.). Full details about how to publish Project results are outlined into the Consortium agreement.

b) Communication activities

All partners will describe, according to their opinion:
- Market impacts of the project
- Market size and potential
- Steps towards commercialization
- Necessity of a European approach

3 – IMPLEMENTATION

3.1 Work plan - work packages, deliverables and milestones

Code 6 (to be written once all Work packages are ready)

(Describe the overall Work Plan based on the activities of the five Work packages.)
Timing of the Work plan (Gantt chart)
Inter-relation of the components (Pert chart)

The following five Work Packages: WP1, WP2, WP3, WP4 and WP5 represent the structure of this Work plan

Table 3.1a: Work package WP1 description

Work package number 1		**Start Date or Starting Event**					
Work package title	**Coordination**						
Participant number	X	Y	Z	W			
Short name of participant	X	Y	Z	W			
Person/months per participant:	X	Y	Z	W			

Objectives

This WP guarantees that:

- an effective coordinating structure is created
- the research project is carried out according to the time schedule and budget established,
- meetings are organized to enable collaboration and management of consortium partners,
- the project progress of the WPs is managed and monitored against contractual deliverables,
- the WPs objectives are achieved efficiently,
- a system is created to provide a continuous evaluation feedback and a constant project monitoring.
- the project is managed according to the contract between the NATECH consortium partners and the EC, maintaining a continuous link with the EC, and the overall legal, contractual, ethical, financial and administrative management activities are performed ensuring accurate and timely distribution of funds, reporting on activities, etc.).

Description of work

WP 1 is the Coordination Work Package, which will last for the whole duration of the project.

1 - Coordinator

The responsibility of the project coordination will be taken by ……… who will supply the Project Coordinator. The project coordinator is responsible for all deliverables.

The coordinator's main activities concern the monitoring and management of the agreed deliverables and milestones in the contract between the consortium and the EC, and the smooth running of the project as a whole. The coordinator will maintain continuous relationships with the General Assembly including the Work Package leaders and will report to the EU. For the day-to-day project management, the Project Officer (PO) supports the coordinator. She/he will focus on the daily management, coordination and administrative and financial aspects of the project.

Coordinator activities:

a) Kick Off meeting.

Upon signature of the contract with the European Commission, the project coordinator will organize an initial kick-off meeting for all personnel involved in the project. This kick-off meeting will enable the participants to obtain a better perspective of their role in the NATECH project. Prior to concluding the contract with the EC, a Consortium Agreement will be signed between the project partners

b) Process Management tasks.

The Project Coordinator will conduct the overall project management, as specified in the contract between the consortium and the EC, i.e.:

- Organize the project meetings, workshops, and receive reports;
- Oversee the drawing up and timely signing of the Consortium Agreement;
- Ensure that all parties will sign the contract with the EC on time;
- Initiate, prepare and preside over regular project progress meetings and the dissemination of information to all partners pertaining to these meetings;
- Act as liaison to the European Commission on behalf of the group in all verbal and written communication;
- Inform the Commission properly about the situation and progress of the work;
- Inform the Commission in advance of the date and subject of the meetings;
- Coordinate the overall financial, administrative and contractual activities of the project, including monitoring and maintaining the overall adherence to the financial budgets;
- Report the overall budgetary situation of the project to the EC, based on the cost declarations from the individual partners;
- Coordinate the dissemination of knowledge and deliverables.

3 - Operational project management

The consortium agreement and contract conditions with the EC will be monitored by the General Assembly to ensure compliance by all participating parties.

For each work package, a WP leader has been appointed to take primary technical control of and responsibility for the proper management and execution of the tasks related to the particular WP. He/she establishes (in co- ordination with the Project Coordinator) the detailed schedule of his/her WP. He/she is also responsible for the quality of, and the correct and timely submission of deliverables relating to his/her WP. Each WP leader is also appointed to chair the meetings among the partners participating to his/her WP and will communicate frequently both formally and informally with the workers in the WP.

4- Monitoring:

a) Internal reporting

In order to monitor and guide the consortium, each individual partner will regularly (after the first four months and thereafter at four-monthly intervals) submit a progress report to the respective Work Package leaders. On the basis of these reports, the WP leaders will monitor progress and take any necessary action to ensure the work package remains on schedule.

Each WP leader is required to provide the PC regularly (after four months and thereafter at four monthly intervals) with a progress report concerning his/her WP and containing sufficient technical information to enable the PC to be assured that work is progressing according to plan.

The status of the project will be updated by the PC in a Project Dashboard that will highlight all key progress indicators of the project and areas at risk.

b) External reporting

The combined WP reports (task of the PC) will be discussed and evaluated during meetings of the General Assembly and will constitute the interim reports and form the basis for the annual and final reports that will be submitted to the European Commission by the PC.

Based on the EU model format the coordinator will ensure that all partners provide a consistent flow of information containing key points on the financial progress in the form of a financial report and associated financial plan, as well as an activity report and updated implementation plan.

c) **Internal communication**

A communication plan will be agreed upon by the General Assembly at the kick-off meeting and will define means and methodology of communication among the project partners.

5- Financial / administrative management

The Project Officer of …… will ensure that all budgetary actions are performed according to the rules and regulations of the EC and the consortium agreement. This includes amongst others establishing a good operating practice for financial management adapted to the financial system of each participating party, to ensure that the received funds are correctly distributed, accounted for, cost statements are received.

Deliverables

– ***Consortium Agreement.*** A Consortium Agreement will be concluded among the project partners.
– ***Kick-Off meeting minutes.***
– ***Meeting/workshop minutes.***
– ***General Assembly meeting minutes.***
– ***Internal website with public areas for communication and data sharing***
– ***Partners progress report.*** Each individual partner will regularly submit a progress report to the respective Work Package leaders in order to monitor progress and to ensure the work package remains on schedule.
– ***Work Package progress report.*** Each WP leader is required to provide the PC regularly with a WP progress report concerning his/her WP to enable the PC to be assured that work is progressing according to plan.
– ***Interim reports.*** The PC will combine the WP progress reports and will constitute the interim reports.
– ***Progress reports to the EC.*** Annually the PC will submit progress reports to the EC.
– ***Final report (technical, financial, deliverables).*** The PC will submit the final report to EC.

Table 3.1a: Work package WP2 description

Work package number 2		Start Date or Starting Event					
Work package title	Diagnostics by nano markers						
Participant number	X	Y	Z	W			
Short name of participant	X	Y	Z	W			
Person/months per participant:	X	Y	Z	W			

Objectives

High performance new facilities and nondestructive and/or nano-invasive methods to be used especially in situ (spectroscopic, spectrometric, diffractometric, electron microscopy techniques) capable to identify qualitatively and quantitatively at nanometric or molecular level the morphology, structure and composition of different materials, together with their compatibility with the substrate, their stability and reactivity, the mechanical and thermal properties, etc. and to detect suitable nano or molecular deterioration markers to be used in fast and inexpensive determination of the state of conservation and of incipient decay processes.

(José F. García)

Nanosensor for atmosphere pollution monitoring.

José F. García, Alex Tarancón_ University of Barcelona. 16.03.15

The presence of pollutants in the atmosphere of the museums and of the underground sites is an important problem for the conservation of the artistic objects and for the health of the visitors and employees related to these spaces.

Fluorescent Polymer based microspheres (FP) allow the detection of different compounds due to the reduction or increase, depending on the case, of the fluorescent signal when these compounds are present. FP has been used to build up microsensors for radioactivity determination. These devices allow the continuous monitoring of the pollutant without reagent consumption or waste generation. These characteristics make FP nanosensors a good alternative for pollutant control.

The experience of the University of Barcelona group developing these sensors let us to propose the same approach for the monitoring of pollutant gases, as sulfur oxides or nitrogen oxides, in museums atmosphere, and Radon, in underground sites.

Preliminary studies about FP for Radon determination show the capability of these materials to continue determination of its concentration. Radon is the main contributor to the radioactivity dose received by inhalation by visitors and employees of underground sites related to cultural heritage. In this scenario, the development of a sensor that permits the determination of Radon activity would be a interesting contribution for the integration of cultural heritage on the society.

On the other hand, the oxides of nitrogen and sulphur above mentioned generated an acid media on the moisture layers located on the surface of all artworks that contributes to some degradation processes. In the project, it will be proposed the development of specific FP based sensor for continues monitoring the concentration of this pollutans on the atmosphere of museums. The information provided by these devices can be followed on time from a remote position allowing a continue control on the quality of the air of the museum.

We want to mention that contribution of the Archive of the Crown of Aragon into Natech includes cooperation with The University of Barcelona.

University of Barcelona / Archive of the Crown of Aragon

(José F. García)

(M. Carme Sistach)

WP3 NANO-SYSTEMS FOR PAPER MANUSCRIPT CONSOLIDATION AND DEACIFDIFICATION

M. Carme Sistach _ Archive of the Crown of Aragon; José F. García_University of Barcelona. 16.03.15

The subject of research in the Archive of the Crown of Aragon has usually been the study of degradation on paper manuscripts: the acidic and oxidative reactions that develop corrosion. This degradation results in fragility and fragmentation of the document that finally is totally lost.

We have been studying measurement of acidity and alkalinity of documents with extreme acidic pH (pH= 3.0-3.5) obtained with extraction and surface pH, the use of gelatine media that provide consolidation, and the results obtained after application of alkaline products: micro calcium particles or calcium hydroxide nanoparticles that provide deacidification. We have information about effectiveness of these alkaline compounds applied in gelatine media, their distribution and penetration on the paper (SEM, FTIR). Consolidation of sheets of paper is also necessary with **extremely degraded manuscripts.**

Study of alkaline nano particles for deacidification and consolidation of acidic manuscripts.

Application of analytical techniques (SEM-EDX, FTIR) to stablish the distribution of particles and pH improvement, and alkaline reserve

(M. Carme Sistach)

(Ioannou Ioannis)

The proposed WP aims to combine existing knowledge on the production of heritage lime-based plasters with the prospects of the new and emerging field of the use of nanotechnology in the building material industry. The main objective will be the design and lab production of environmentally-friendly, durable and compatible plasters for application in heritage buildings. The lab produced nano-modified composites will be fully characterized, both in their fresh and hardened states, following an interdisciplinary multi-level approach using advanced analytical techniques and standardized methodologies where available. The durability of the composites against salt crystallization and frost action will also be investigated. The most promising end-products will be applied in heritage monuments exposed to different climatic conditions and their in-situ performance will be continuously monitored.

(Ioannou Ioannis)

Description of work

(Ioannou Ioannis)

A series of at least 30 laboratory plaster mixtures will be designed, based on a parametric study which will investigate the effects of various raw materials and several parameters on the properties of the end-products. Hydrated and natural hydraulic lime will be the primary binders under study. Since the application and required properties of plasters diverge, special attention will be given to aggregate grading in order to ameliorate the packing density of the solid constituents of the laboratory mixtures. Crushed aggregates will be selected for all mixtures. The UCY research team has vast experience in characterising aggregates and its database of results will therefore be of paramount importance in the selection procedure.

Aiming at achieving the optimal syntheses, a series of binder/aggregate ratios will be defined and investigated. The influence of admixtures, such as natural or artificial pozzolanas, nanosilica and nanotitania on the properties of the hardened composites will be tested by incorporating them into the mixtures in various proportions and combinations. Based on the experience of the UCY research team, the concentration of nanosilica and nanotitania in the mixtures will not exceed 10% w/w of the binder. The parametric study of the mix designs will indicate the impact of the aforementioned variables on the performance of the composite materials.

Consistency/workability measurements will be carried out following the EN 1015-3. The bulk density of the fresh materials will also be measured according to the EN 1015-6. The setting time of the mixtures will be determined in accordance with EN 196-3. All the aforementioned tests refer to the properties of the fresh mix and will fully characterize the materials at the first production stages. Several types of moulds will be used depending on the parameters of each proposed test. Moulds fabricated out of natural building materials will also be used, in order to investigate the effect of porous substrate on the properties of the laboratory mixtures, simulating the application of the end products in-situ. Specimen curing will be based on EN 1015-11.

TG/DTG will be performed daily within the 1^{st} week and at 1, 3, 6, 9 and 12 month periods after the production of the materials to determine both the carbonation and hydration rates of the mixtures. Energy dispersive X-ray fluorescence analyses (ED-XRF) will additionally contribute towards the evaluation of hydration rate, by estimating the content of soluble silicon (Si). At the same time intervals, the evolution of specimen hydration will be investigated using Fourier Transform Infrared Spectroscopy (FTIR).

The determination of the evolution of mineral phases will be carried out by means of XRD at the beginning and after 3, 6, 9 and 12 months to determine any changes in the mineralogical composition of the samples. The microstructure and texture of the specimens will also be examined after 1, 6, 9 and 12 month intervals by means of stereoscopic and polarizing microscope; in order to study the specimens at nanoscale, a SEM will be used, while EDS will allow a simultaneous semi-quantitative analysis of the chemical composition of the binder and of the binder-aggregate interfaces.

Mechanical tests (EN 1015-11) will provide an evaluation of the materials' flexural and compressive strengths. The static elastic modulus of the hardened composites will also be determined with the use of strain gages. Ultrasonic pulse velocity measurements will be further used to determine the dynamic modulus of elasticity of the composites (BS 1881-203 &209). Micro-destructive techniques (scratching and drilling) will be employed to correlate the results of standardized and other tests. Both techniques have proven useful in such correlations. The DRMS will also be used in-situ for the monitoring of the plasters which will be applied in heritage monuments.

The physical properties of the composites i.e. open porosity, apparent density and capillary absorption using water and organic liquids will be also determined. Permeability measurements using a Hassler cell apparatus will be additionally performed. All the aforementioned properties serve as durability indicators of hardened composite materials. The distribution of pore sizes will be determined by MIP; this will provide important information about the pore structure and volume within the materials, which in turn influence their liquid transport and water-mediated durability properties. All the aforementioned (mechanical and physical property) tests will take place at 1, 3, 9 and 12 month intervals from the production day of the specimens.

The durability of the end-products against salt crystallization and frost action will be tested after 6-month curing. In the absence of a proper salt crystallization test for traditional mortars, this will be developed by the research team and will be based on partial immersion using different salt solutions. For the freeze-thaw test, full immersion will be adopted. The properties of the specimens will be tested before and after the end of the crystallization/frost cycles.

The most promising mix-designs will be applied to heritage monuments exposed to different climatic conditions. Their performance, as well as the environmental conditions at each application site, will be continuously monitored. This will provide valuable feedback for the durability of the composites.

(Ioannou Ioannis)

Deliverables

(Ioannou Ioannis)
D1: Report on the design, production and characterization of laboratory mixtures
D2: Report on the in-situ performance of the nano-modified plasters.
(Ioannou Ioannis)

Table 3.1a: Work package WP3 description

Work package number 3		**Start Date or Starting Event**					
Work package title	**Restoration by nano-systems**						
Participant number	X	Y	Z	W			
Short name of participant	X	Y	Z	W			
Person/months per participant:	X	Y	Z	W			

Objectives

· *clearing procedures based on micelles and nano-emulsions or other nano-systems as nano-structural gels.*
· *calcium alkoxides: tailored nano-products as consolidants and coatings, especially for the conservation of historical buildings. Some examples are nano-dispersions as $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$, $Sr(OH)_2$), as consolidants of suitable carbonated substrates (marbles, etc.).*
· *Silane/syloxane, acrylic and silica nano-dispersions, using inorganic, organic and mixed consolidant products.*
· *Nano-silica injected in the substrate of wall paintings. This action could be alternative to nano-lime actually used while zirconia and/or alumina nanoparticles can improve mechanical resistance of artwork surface layer and go deeper inside the body of the piece.*
· *polymeric nanosilicate nanocomposite (nanofillers into a polymeric matrix)*
· *photocatalytic cement-based materials*
· *bio deterioration restoration based or nano biocatalysts*
· *functionalized alkoxy silane for deacidification and consolidation of paper..*
· *carbon nanotubes for mechanical improvement of timber structures.*

(Perkiomaki Kirsi)
The main goal of this WP is to select and test the best commercial available thin sol gel film coatings and test their suitability for the use in restoration of different metal materials. Objects tested are manufactured from iron, copper, brass and bronze alloys and used in architectural site, for example in open-air museums. The aim is to gain the long term corrosion and wear resistance, anti-scratch and easy-to-clean properties as well as take into account the decorative aspect.
(Perkiomaki Kirsi)

(Sandak Anna)
The **Laboratory of Surface Characterization** provides a series of integrated services for the determination of characteristic of bio-based products surface parameters, the evaluation of the surface durability, before and after processing/weathering, the compatibility of the finishing techniques with the requirements of economical and ecological sustainability.
We have experience with a long-term performance and durability of wood surfaces that can be experimentally evaluated according to two testing modalities: outdoor exposure or artificial weathering. Beside standard weathering machines, limited to the ageing to radiation and water resistance we use prototype weathering machine that allows simulating the real changes of climate such as seasons, day/nigh, rain/acid rain, solar radiation, freezing of the surface, soil contact. In particular, the machine is composed of two chambers simulating two different climatic/seasonal conditions: the "summer" chamber and the "winter" chamber.
We evaluated wooden samples exposed to the biotic degradation, waterlogged for short and long term period and cultural heritage objects. We tested various products used for wood protection (coatings containing nano particles, titanium dioxide etc.). We evaluated various paper products reinforced with natural or synthetic additives. We have also investigated performance of natural products used for wood conservation in the past and confronted it with real case samples (manor houses floors in this case). We have experience also with multi-scale modeling of materials performance and prediction of service life of wood elements or structures.

The lab can contribute in WP2: Diagnostic with Nanosystems/Nanodevices:????

- Provide know-how on the determination of the various wood degradations; including ageing, weathering, fungal decay, or waterlogging
- Provide complex characterization of wooden samples from dendrochronological, anatomical, physical and chemical point of view.
- Perform analysis of the photodegradation of wood surfaces due to electromagnetic radiation
- Develop monitoring tools for in field measurements and monitoring, using different sensing techniques (IR, NIR, XRF spectroscopies, color, gloss, wettability etc)
- Provide acoustic characterization of material properties and whole objects by using ultrasound, free vibrations, directional microphones, acoustic emission and other methods
- Perform natural and artificial weathering test
- Studies on mechanisms and defending strategies against degrading agents acting on wood
- Numerical analysis and in-field measurements of the water-wood relations in the historical objects including wall painting and other wooden artifacts (within collaboration with LABESS- Laboratory of wood drying and Thermal treatment)
- Contribute in the development and characterization of innovative nano-based products and their performance in applications related to wood and wood-based products
- Provide collection of wood samples that are dated dendrochronologicaly and might served as samples for verification of innovative treatments developed within this project (within collaboration with Laboratory of Dendrochronology)

(Sandak Anna)

(Bondioli Federica)
The ligno-cellulosic materials (**wood** and **paper**) are conveniently used for a variety of human artifacts in virtue of their advantageous characteristics. However, theyare subjected to physical, chemical and biological deterioration.

1 Preservation and consolidation of wood
Wood is conveniently used as material for a variety of human artifacts in virtue of its advantageous characteristics, such as high tensile strength, high elastic modulus, low density and insulation properties. However, its organic constitution makes it prone to combustion and to long-term oxygen light and water degradation. Moreover wood is a source of nutrients for fungi and insects leading to its complete biological destruction. Therefore, a lot of treatments have been essayed in the past trying to overcome these drawbacks and enhacing wood durability. This can be obtained by improved moisture sorption characteristics, dimensional stability, strength and hardness, weathering performance, flame resistance and resistence to biotic decay. Among them, a wide range of compounds have been tested for wood modification, including anhydrides, carboxylic acids, isocyanates, aldehydes, alkyl chlorides, lactones,

nitriles, and epoxides. The main problem in using these systems is the release of unfixed species in the environment and the problem of waste of the manufacts at the end of their life cycle.
Also many types of silicon compounds have been used for this purpose, in particular alcoxysilanes as starting materials for the sol–gel process. Polymeric siloxane materials can be obtained by sol–gel processing both tetraalkoxyslanes, like $Si(OEt)_4$, (TEOS) and trialkoxysilanes, like $RSi(OEt)_3$, bearing organic functional groups with desired properties. The presence of amino functions, as recently proposed by us, leads to fix copper(II) cations through coordinative interactions, giving strong antifungine properties to the treatment.
On the other hand modern nanotechnology offers the tools for impregnating and modifying wood with active compound (nanosols) at a molecular level, creating strong interactions between wood natural polymers and the artificial eco-compatible nanosols and so minimizing or avoiding leaching and life-cycle problems. This is just the case of inorganic and hybrid inorganic-organic nanosols containing siloxane frameworks.
Continuing our investigations in this field, we have considered polyamidoamines (PAA) as suitable materials able to interpenetrate wood, to modify its physico-chemical characteristics and to act as consolidants and preservants against biotic decay. Preliminary results indicate that PAA effectively penetrate inside the wood and are very active alone against fungus Coniophoraputeana. Moreover, PAAs are able to fix and vehiculate metal nanoparticles and metal cations so eventually extending their spectrum of biocide activity.
The fundamental aim of this research project is to develop an innovative treatment of wood for its consolidation and protection against biotic and abiotic decay and minimizing the release of undesirable chemicals in the environment. It consists in the application of I.-O. hybrid nanosols, in particular polyamidoamines (PAA) polymers containing hydrolyzablesiloxane moieties and other functional groups, producing an hybrid wood composite, which could also be subjected to thermal treatment. The realization of this plan passes through seven specific objectives: (***i***) production via sol-gel of novel composites, obtained by interpenetrating wood with hybrid siloxane materials, endowed with useful physico-chemical properties; (***ii***) eventual modifications of the obtained composites through thermal treatments; (***iii***) investigations on the physico-chemical properties of the obtained wood composites (***iv***) studies on the interactions between wood polymers and the hybrid siloxane network at a molecular level before and after thermal treatments; (***v***) evaluation of the environmental impact of the proposed technology.

1 Cleaning and preservation of paper

It is well known that the conservation of paper artworks depends on different aspects correlated to the intrinsic nature of cellulose (the main component of paper), papermaking and materials added, including inks, but also the interaction between paper and environment can play an important role. In fact, external contaminants, deposition materials, salts, metals, spores, and even organic acids on paper may promote degradation processes of cellulose (i.e.: hydrolysis, oxidation of cellulose) resulting in the acidification and mechanical weakening of paper and compromising the structural integrity of paper.
Moreover the presence of dust and airborne particles, in combination with specific environmental conditions promote mold growth and pest infestation in paper artworks. These organisms can release enzymes, promoting cellulose hydrolysis and producing at the same time metabolic products of acidic nature and pigments. The consequence is an aesthetical, physico-mechanical damage, the formation of specific stains, foxing, often of biological origin.
In this context and apart from aesthetical considerations, cleaning treatments become crucial for the stability of paper artifacts and archival materials. The removal of such particles by means of cleaning treatments is fundamental to chemically stabilize and preserve artifacts over time.
In addition, cleaning treatments result also in preliminary deacidifiction of paper.
Traditionally, cleaning treatments have consisted of dry methods (mostly based on erasers, brushes and any other material that help remove mechanically the dirt from the surface) and wet ones. Some traditional dry cleaning treatments have proved to be too aggressive and could partially damage paper surface morphology typically resulting from manufacturing.
On the other hand most of the common wet cleaning treatments have been traditionally based on the use of water because of its polarity thus allowing partially extraction of degradation products and reinforcing the cellulose structure by building hydrogen bonds up.
In these last years research has been focused on the development of wet cleaning treatments consisting on the use of water in a gelled form. By doing this the release of water in the paper can be reduced and controlled and therefore the risks of dimensional change can be minimized.
For this purpose, water gelling agents with high viscosity such as agar and gellan gum gels can be used. The application of such rigid polysaccharide gels makes the water intake by paper gradual depending on the gel concentration.This aspect can be advantageous from a mechanical and structural point of view but also in case of works of arts characterized by the presence of water sensitive medias.

In this research the application of polyamidoamines for deacidification of paper will bestudied.
The study will befocused on the evaluation of deacidifying effect of polyamidoamine on acid papers by comparing three different modality of application: immersion of paper in deacidifying solution containing polyamidoamine, application of rigid gel of Agar containing polyamidoamine and application of polyamidoamine in water-ethanol solution by brush. The application considered different polymer concentrations in alkaline and neutral pH.
Preliminary papers were characterised by Fourier Transform Infrared Spectroscopy analysis, pH surface measures, colorimetric analysis. The deacidification treatment on papers was, then, evaluated by FT-IR analysis, pH surface measures, measure of anhydrous mass, Scanning Electron microscopy analysis.
(Bondioli Federica)

(Paladini Alessandra)
1. This Work package combines photophysical, photochemical and ICT with the aim to characterize the composition of both fixed (i.e. wall painting, plasters, mosaics) or movable (i.e. pictures, decorate pottery also as fragments) items of interest for the cultural heritage. Non-destructive and/or nano-invasive spectroscopic techniques will be used and aportable Raman spectrometer will be developed for in situ analysis.
2. Production and testing of nanocomposite materials for Surface Enhanced Raman Spectroscopy (SERS) in order to develop high performance Raman systems in the field of Cultural Heritage.
(Paladini Alessandra)

(Pangallo Domenico)
It is already know that the microbial community can cause different anaesthetic problems on various items representing our cultural heritage.
Therefore, it is very important to consider the degradation activities of contaminating microflora and the influence of microbial communities to the new-developed restoration-conservation strategies.
Several nano-materials are promising to be used in preservation applications of our culture heritage. But it is necessary to assay also their potentialities against the microflora that could be affected the surface and structure of historical and/or artistic objects.
Moreover, some nano-materials can eliminate for a certain period the microflora, but other more dangerous communities can contaminate again the surface causing more extensive damages.
It is important to properly test all the new nano-based restoration-conservation materials in order to avoid other unpleasant and more fastidious issues.
(Pangallo Domenico)

Description of work

(Perkiomaki Kirsi)

- selection of the commercial sol gel coatings
- Preparation of coatings on different metal surfaces
- (Artificial ageing in laboratory conditions)
- Characterisation of the properties of coatings like thickness, decorative aspect, wear resistance, easy to clean and corrosion resistance. This is done for example by measurements of contact angles and observation of the surfaces by SEM-EDS

- selection of the best commercial sol gel coatings among previous products
- Selection of the objects to be restored
- Testing the suitability of coatings in real conditions. This might demand longer testing period. For example one year is good time cycle in Finland: we have sunlight and temperatures up to + 30 degrees in summer time (from June to August) and on the other hand very low temperatures down to -25 degrees in winter time (from December to february).

Characterisation of the properties of coatings like thickness, decorative aspect, wear resistance, easy to clean and corrosion resistance. This is done for example by measurements of contact angles and

observation of the surfaces by SEM-EDS
(Perkiomaki Kirsi)

(Bondioli Federica)
1 Preservation and consolidation of wood
A series of strictly connected activities will be undertaken in the framework of the present project: these activities are closely related to the specific objectives described above and are reported below along with expected deliverables.
(*i*) The first specific objective requires extensive synthetic activity to produce PAA polymers, in particular HOPAA with alcoholic functions and SiPAA, with alkoxysilane groups. Solubility and sol-gel processability (only for SiPAA) characteristics will be investigated along with impregation reactions with wood samples. Samples will be suitable both for fungal decay test and for physical properties investigations. Reactions of PAA polymers with metal cations and metal nanoparticles will be also studied.
Precise synthetic conditions, lists of useful characterization data, sol-gel processing and impregnation protocols, along with new polymers and composites will be the expected deliverables of this specific project.
(***ii, iii***) This specific objectives require important technological activities which include mainly sorption tests, permeability tests and dimensional variation studies on wood modified with nanosol materials. Moreover thermal treatments on the same treated wood samples will be carried out. New modified wood materials and useful lists of relevant physical data are the expected deliverables.
(**iv**) The pursuit of the fourth specific objective will produce a lot of valuable physico-chemical data collected with the most advanced characterization techniques of material science. It is expected that critical examination of these data will give important informations on the interactions between lignocellulosic polymers and artificial hybrid PAA nanosols. This precious informations, which could suggest modifications in the synthetic procedures, will represents the deliverables of this part of the project.
(***v***) The pursuit of this objective will give information on the resistence of treated wood against fungal dacay and against leaching phenomena, under controlled laboratory conditions. Both test are decisive on the applicability of the obtained wood composites. Collected data will be used to improve the preparation procedures and will represent the deliverables of this section.

1 Cleaning and preservation of paper
In this study innovative cleaning and deacidification systems based on the application of polyamidoamines polymers(PAA) will evaluated on different paper samples. For this purpose, preliminary papers will be characterised by spectroscopic, microscopic and analytical techniques.
PAA will be functionalized either with alcoholic functions (HOPAA) in order to increase solubility and the interaction strength to cellulose, or with alkoxysilane dangling groups (SiPAA), in order to give inorganic reticulation by the sol-gel process.
Firstly, the application of such polymer will be carried out in water solution, at different concentrations, in alkaline and neutral conditions. In addition, a second methodology of application will be evaluated based on the preparation and application of rigid gel of Agar (water-alcohol solution) containing polyamidoamines. The water-ethanol solution contained in the gel can be released gradually. The advantage of this new method is the possibility of preparing simple, controlled deacidification systems which can be adapted to structural, physical properties of paper.
The study will be focused on the evaluation of the effects induced by deacidification treatments withpolyamidoamine on paper properties, by means of surface pH measurements,Infrared spectroscopy, Scanning Electron microscopy with X Ray energy dispersion, colorimetric analysis and evaluation of changes in anhydrous mass of paper samples. The study will include also thermo-hygrometric accelerated aging of samples (NORMAL UNIISO 5630-3 2005) after deacidification treatment, in order to evaluate if samples subjected to deacidification treatment could be more prone to degradation than the control.
In addition the effect of the treaatments on inks will be evaluated.
(Bondioli Federica)

(Paladini Alessandra)
1. A graphical reconstruction of the surface will be preliminary performed, in order to localize the micro-areas to be analyzed. Whenever possible Open Source software will be used.
In situ. A portable Raman Spectrometer will be used for investigate the composition of the artifacts. The probe of the spectrometer will be mounted on a XY translational stage in order to scan the surface. Actually, the Institute is acquiring part of the portable instrumentation, which will be furtherly implemented in the frame of this project.

In laboratory. The artifacts or their fragments will be analyzed by □-Raman and Laser Induced Breakdown Spectroscopy (LIBS). If further analysis are requested, all the micro-destructive(optical, spectroscopic and diffrattometric)diagnostic techniques available in the Institute will be used. As the Institute has also a research unit at Elettra, the Synchrotron Radiation Laboratory in Trieste (Italy), synchrotron X-ray diffraction analysis can be performed on selected samples.
The studies can be performed also on micro-fragments of the artifacts, which can be collected in collaboration with qualified personnel, in order to be as less intrusive as possible.

2. New nanostructured materials for application in Surface Enhanced Raman Spectroscopy (SERS) will be also investigated. In particular, carbon based materials coupled with metal nanoparticles will be produced by means of Pulsed Laser Ablation in Liquid, and their efficiency in performing □-Raman Spectroscopy of artifacts will be tested.
(Paladini Alessandra)

(Pangallo Domenico)
- The microbial analysis by culture-dependent and culture-independent (direct analysis of the microflora by DNA and/or RNA-based methods) approaches of different contaminated cultural heritage objects before the application of restoration-conservation strategy.
- Used of the isolated microflora to assay the biocide effect of nano-materials *in vitro* using plate agar or microplate tests. Construction of model samples to be contaminated with isolated microflora in order to establish the de-contamination power of nano-materials *in situ*.
- Evaluation of the data for the development of a suitable and reliable restoration conservation strategy for a specific art objects material.
- Application of the nano restoration-conservation strategy in real contaminated items.
- Evaluation of the effectiveness of the restoration-conservation strategy reanalyzing the specific object by culture-dependent and culture-independent approaches.
(Pangallo Domenico)

Deliverables

(Perkiomaki Kirsi)
Preparation of coatings on different metal surfaces and artificial ageing (for 8 weeks?). Results of ageing and measurements done by the end of year 2015

Selection of objects, their preparation 01/2016
Ageing of objects in open-air museum for one year period (delivery 02/2017)

Observations and measurements of the coatings on objects spring 2017
Results are to be published in some proper congress
(Perkiomaki Kirsi)

(Bondioli Federica)
Besides the **production of new, effective inorganic-organic hybrid nanosystems** able to preserve, consolidate and clean ligno-cellulosic materials, the following two items are also to be considered.
(***a***) Deliverable of this project is also the creation of a new motivated team of experts in wood and paper treatments with nanomaterials and in their characterizaton. This will reinforce the potential of joined Institutions and will produce new links with various research/educational Institutions through scientific contacts and training students.
(***b***) Transferring knowledge is the last specific objective of this project. This will generate a lot of important deliverables by contacting and visiting working industries, by participating to workshops, training courses and conferences, by publishing results on referred journals and also by creating a web site, pamphlet and books.
(Bondioli Federica)

(Paladini Alessandra)
- Production of nanocomposite system for SERS. (T0 + 12)
- Development of a portable Raman spectrometer. (T0 + 12)
- Test of nanocomposite system for SERS on model systems. (T0 + 24)
- Best practice guidelines for the used diagnostics. (T0 + 24)
- The compositional characterization of the artifacts. (T0 + 36)
- Test of nanocomposite system for SERS in situ (T0 + 36)
- A multimedia database (available also online) containing all the obtained information. (T0 + 36)
- A GIS (Geographic Information System) platform containing all the obtained information. (T0 + 36)
- Data integrated in the project website. (T0 + 36)
- Papers in scientific journals and communications at conference.

(Paladini Alessandra)

(Pangallo Domenico)

Development of restoration and conservation strategies by the use of novel nano-materials against the microbial contamination.

(Pangallo Domenico)

Table 3.1a: Work package WP4 description

Work package number 4		**Start Date or Starting Event**					
Work package title	**Conservation by nano – systems**						
Participant number	X	Y	Z	W			
Short name of participant	X	Y	Z	W			
Person/months per participant:	X	Y	Z	W			

Objectives

· *Organic resins used in latest fifty years demonstrated poor time and weather resistance. In some cases they worsened the appearance and the conditions of the artwork. The use of inorganic coating can override these problems, due to their long term stability; moreover, it can improve the "self-conservation" of the artwork, for example in the case of titanium dioxide, that gives self-cleaning (super-hydrophilicity) and antimicrobial effect to the treated surface.*

· *Organic inhibitors, such as 4-methyl-imidazole, 2-mercaptobenzothiazole, 1-phenyl-tetrazole-5-thiol, 3-amino-1,2,4-triazole and 3-ethyl-4-methyl-5-imidazole-caboxylate, and thin protective nano-structured films produced via environmentally friendly plasma based techniques have been selected on the base of their potential activity on a nano-scale dimension to inhibit the cyclic copper corrosion.*

(Sandak Anna)

Laboratory of Chemistry of Wood and Wood products

The activities of the laboratory of wood chemistry and wood products cover various aspects of chemical technologies applied to the wood sector. These activities include the assessment of chemical composition of wood, measurement of calorific value of wood and wood products, characterization of adhesives and gluing products (both for structural and non-structural use), and study of the interphase between wood and adhesives or between wood and coatings. The main applications of these activities involve several fields, from the Conservation of Cultural Heritage (diagnostics, restoration and conservation of material from both archaeological excavations and timber structures) to the productive and industrial Systems.

The lab can contribute in WP3: Restoration by Nano-systems and WP4: Conservation by Nano Systems Development of advanced compatible nanostructured materials for the stabilisation of waterlogged archaeological wood.

Aim of this activity is of improving the features of traditional materials in order to increase their penetration depth and consolidation capability, thus to develop new agents for the conservation of waterlogged archaeological wood. This activity can be developed through various steps including:

- Production of cellulose nanowhiskers,
- Developing techniques for the effective dispersion of cellulose nanowhiskers in the improved products,
- Application of the improved products to wood samples,
- Evaluation of the effectiveness of the developed improved products.

More info regarding our current and past activities can be found here:
http://www.ivalsa.cnr.it/en/projects.html
(Sandak Anna)

(Bondioli Federica)
Organic resins used in latest fifty years demonstrated poor time and weather resistance. In some cases they worsened the appearance and the conditions of the artwork. The use of inorganic coating can override these problems, due to their long term stability; moreover, it can improve the "selfconservation" of the artwork, for example in the case of titanium dioxide, that gives self-cleaning (super-hydrophilicity) and antimicrobial effect to the treated surface.

1. **Engineered titania coating to protect stone and painting**

Over the years technical developments always play a role in preserving cultural heritage. Printing, photographing, voice recording, and during the last decades, the cyber revolution were, are, and will be used to protect the spiritual and conceptual assets of culture, as well as to deliver the images of tangible cultural assets. While progress achieved in preserving the audio and visual images are tremendous, the preservation of the actual tangible cultural assets, like sculptures, buildings and paintings, seems to lag behind. The time is arrived to step forward from utilizing modern technology for preserving the images of cultural assets to the use of cutting- edge technology for the purpose of preserving actual, tangible cultural heritage artifacts namely sculptures and paintings. Frescoes and paintings in museums, as well as sculptures and historic stones, in fact, are inevitably subject to deterioration over time. The extent of deterioration depends on the environmental parameters, such as exposure to ultraviolet and visible light, relative humidity, particulates, atmospheric gases and pollutants.
It is for this reason that we propose to use ultrathin innovative coatings, formed from nano-particulates, for the purpose of preservation of cultural heritage assets. The concept here is to provide **maximal protection with minimal thickness** (hence also minimal side – effects), and, hopefully, with minimal cost, thus facilitating wide-range implementation. These coating are expected to function not only independently but also in a manner that is compatible with existing preservation technologies. In principle nanodispersions of solids, micelle solutions, gels and microemulsions offer new reliable ways to restore and preserve art works by merging together the main features and properties of soft-matter and hard-matter systems, allowing the synthesis of systems specifically tailored for the art works to fight the deterioration processes which threaten many priceless masterpieces. In addition, the characteristic nanoparticle multifunctionality could be the winning tool for creating surfaces that, becoming self-cleaning or hydrophobic, could increase the preservation of the final product. In this scenario, the first object is to extend beyond the developing of a specific means for preservation. It aims at revolutionizing the concept of preservation of artifacts, while tailoring the solutions according to specific challenges. For this reason we find it a necessity to demonstrate the proposed approach on two different archetype of systems suffering from different problems: sculptures and paintings. More specifically, it is proposed hereby to develop two classes of **surface-engineered nanoparticles**, especially designed for increasing the self-cleaning ability of historical stones and preserving paintings. The use of nanopowders (that can be considered transparent to the human eyes) guarantees,

together with the improvement of the surface properties, the product aesthetical characteristics, key factor from a cultural heritage point of view. The introduction in the coating of inorganic material nanoparticles should lead to an increase in the superficial mechanical properties and, according to the specific requirements will utilize solar light to obtain photocatalytic, autocleaning and antibacterial activity (application on stone) or will block deleterious UV light (application on painting).
The main objective of this research is, thus, to develop means for treating the surface of tangible cultural assets (both historic stones and paintings) in order to improve their mechanical (resistance to scratch, wear), chemical-biological properties and aesthetic properties, while focusing on minimizing optical side effects and cost.

(Bondioli Federica)

(Rodica Ion)

The project will be focused on historic and novel materials, their compatibility prior to application and ageing in order to prevent future deterioration on cultural heritage objects, preserve them and improve their physical, functional and aesthetic state. The Main objectives of this WP are characterization of historic materials in laboratory and on the site, design and development of advanced and environmental friendly cleaning and protective materials and study of compatibility. The work will be based on selected and movable objects. This includes:

 selection and characterization of historic materials, preparation of model substrates, simulation of degradation and comparative of aged and nonaged model substrates

 identification of target performances for newly materials: establishment of methodology for characterization

 synthesis of innovative environmental friendly materials: consolidant and cleaning and protective coatings based on the activated clay support

 compatibility, application and retreatability of the advanced materials in laboratory conditions: determination of the most efficient technique of cleaning, application, durability of innovative materials and investigation of compatibility with the historical materials.

- cleaning procedures based on nanostructural gels (micelles and nano-emulsions or other nano-systems).
- tailored nano-products as consolidants and coatings, especially for the conservation of historical buildings: nano-dispersions as $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$, hydroxyapatite and its metallic derivatives, as consolidants of suitable carbonated substrates (marbles, chalk stone, etc.).
- Nanolime, zirconia and/or alumina nanoparticles with improved mechanical resistance of artwork surface layer with consolidation power deeper inside the body of the piece.
- Clays and nanosilicate nanocomposite (nanofillers into a polymeric matrix)
- photocatalytic cement-based materials (based on TiO_2).
- functionalized alkoxy silane for deacidification and consolidation of paper alone and with wax seal.
- functionalized alkoxy silane for deacidification and consolidation of paper.
- bio deterioration restoration based or nano biocatalysts

carbon nanotubes for mechanical improvement of timber structures.

(Rodica Ion)

(Pollio Antonino)

To assess the effectiveness of nanotechnology-based treatments on model biofilms

Damage to lithic substrates caused by microorganisms is often referred to as bioweathering or biodeterioration.Most microbes live in populations and rely on population-level traits for their survival. Artificial biofilms can be powerful models to test in the laboratory the effectiveness of new strategies of control, by allowingindependent manipulation of parameters.

In our lab are currently maintained in culture strains of bacteria, cyanobacteria, algae, and fungi that commonly cause bioweathering of lithic substrates. A number of them comes from sampling campaigns carried out in Pompei, Herculeneum and Oplonti archeological sites. Samples of biofilm were gently scraped from frescoes, mosaics, or different kind of stones, and their microbial components were subsequently isolated in the lab.

Our goals are:
- Test the bioreceptivity of some lithic substrates comparing the ability of attachment to substratum of selected strains of microbes.

- Characterize the three-dimensional structure of single microbial populations on substrates, to assess the potential ability of each strain to allow the establishment of heterogeneous biofilms.
- Build heterogenous biofilms made of at least four microganisms, representative of bacteria, cyanobacteria, algae and fungi.
- Develop methods to follow the growth of heterogeneous biofilms on different substrates
- Make available the model biofilms for the other units of the project.

Model biofilm construction and growth will be studied with different techniques, including Laser Confocal Microscopy, PAM fluorometry and Real Time PCR for mRNA quantification.
(Pollio Antonino)

Description of work

(Bondioli Federica)
This task is divided into two parts that will be run in parallel.
1. Nanoparticulate films for historic stones: these films are required to be highly photocatalytic (to provide self-cleaning properties) and should be mechanically and optically compatible with the substrates. Nanopowder suspensions of inorganic materials such as TiO_2 and ZrO_2 will be prepared by sol-gel in a silica matrix. The titania nanoparticles, in the anatase polymorph, will assure photocatalytic, autocleaning and antibacterial activity while the other inorganic nanoparticles will serve to increase the hardness, toughness, and adherence of the final product. In particular, to increase the absorption of visible light, several metallic and non metallic doping agent will be evaluated. For optimizing the composite sol-gel coatings, the kinetics of the consolidation process will be studied, to obtain formulations that can be consolidated at temperature and time compatible with Cultural Heritage. Nano level characterization of the obtained products in terms of microstructure, tribological, catalytic, and technological properties (based on the UNI EN ISO reference rule) will make the evaluation of the most efficient treatment. Particular attention will be given to test the coating on a large variety of substrates in order to meet conservation and compatibility requirements for historic stones (sympathetic conservation). As part of this, a considerable amount of efforts will be dedicated to preserve the aesthetical aspect of the final products. These efforts will include aiming at reducing the thickness of the film without harming its self- cleaning properties and at the same time constant monitoring of the obtained hue values.
The program will be divided into following phases: 1) preparation of nanopowders and sol-gel matrix; 2) manufacturing of preliminary specimens by depositing the film on stone specimens; 3) characterization of the preliminary specimens; 4) optimization of the process (feedback from 3) and manufacturing of the materials samples at a laboratory scale; 5) characterization of the samples; 6) durability tests and application on site. Because of the broader awareness possible environmental impacts of products through the different phases of their life cycle, the project will try to assess the environmental impacts generated by the innovative products and processes using a Life Cycle Assessment (LCA) methodology.
2. Nanoparticulate films for the protection of paintings: unlike the nanoparticulate films for stone substrates, protective films to be applied on paintings are required to be totally UV-inactive (yet UV-blocking), fully transparent under visible light and compatible both with oil-based pigments and with water-based pigments. Both TiO_2 and ZnO have high absorption coefficients under UV light, hence can be used to block deleterious UV light from reaching the underlying pigments. Nevertheless, TiO_2 as anatase is UV active, hence might enhance radiation damages. Therefore, within the framework of this task, titania nanoparticles will be prepared in order to obtain rutile polymorph (lower UV activity) and in manners that will retard its photocatalytic activity i.e. overcoating to block formation of surface OH radicals. All particles will be fully characterized and once 3-4 types of most the promising particles will be outlined, the research focus will be altered towards aspects of deposition, in particular adherence and homogeneity of the films. Care will be given to follow any color change upon application of the films, and most important, to follow protection virtues upon exposure to high flux of UV. These measurements will be performed on canvases painted first with single colorants at a time (candidates include madder lake, alizarin, purpurin). These studies will then continued with studies with real dyes, i.e. with canvases painted with binder (i.e. gum Arabic)- containing dyes. It is well known that humidity plays a significant role in the fading of several dyes. For this reason, the performance of the ultrathin layer as a humidity- blocking layer will be studied in parallel. The program is

divided into following phases: 1) preparation of nanopowders; 2) manufacturing of preliminary specimens by depositing the powders on different types of specimens exspressely prepared to simulate colors and binders of paintings; 3) characterization of the preliminary specimens; 4) optimization of the process (feedback from 3) and manufacturing of the materials samples at a laboratory scale; 5) characterization of the samples; 6) durability tests and application on site; 7) LCA analysis.
(Bondioli Federica)

(Rodica Ion)
The research methodology involves activities as follows: selection and characterization of cultural heritage objects (movable and immovable), synthesis and laboratory production of nano-composite materials, development of new cleaning procedures, in-situ application and monitoring the materials functionality on the selected historical buildings and artworks providing their life cycle assessment.
The results will be obtained on different **historic materials** (stones, chalk stone, mortars, bricks, renders, pigments, binders, concrete, plastic), that will be characterized in situ and in laboratory methods: X-ray powder diffraction, Raman microspectroscopy, optical microscopy, SEM/EDS, thermal analysis, FTIR spectroscopy, compressive strength, adhesive strength, mercury intrusion porosity, volume change, frost resistance, salt crystallization test, content of soluble salts. Based on the obtained results the preparation of **model substrates** and their **ageing** will be conducted for novel materials examination and testing.

The decision for **development of new advanced materials** for cleaning and protection procedures will be done according to the **compatibility criteria** among materials. Three types of novel materials will be designed: cleaning materials, consolidants and protective coatings. For the **cleaning** of mineral substrates (bricks, stones and concrete) of the chosen degraded objects, an innovative combination of the traditional desalination method (poultices) is planned to be developed. The **advanced materials** (consolidants and photocatalitically active protective coatings) will be developed and tested in research and laboratory. The selected consolidants and coatings will be tested SEM/EDS, FE/SEM, spectroscopy in the UV, visible and infrared region, serving for the characterization of microstructure and understanding of chemical reactions in the structure of the coatings during the UV irradiation. The **functional properties** of the designed consolidants and coatings will be tested by methods already developed, modified or adopted: photocatalytic efficiency, Drilling Resistance method – DRMS, Raman and IR spectroscopy for determination of the rate of consolidation. Some relevant physical and durable properties will be investigated: water absorption, water vapour permeability, colorimetry, resistance to different weather conditions and influence of composition and preparation of functional coatings on the bond strength on different substrates.

PROTECTIVE MATERIALS FOR STONE SUPPORTS
A good approach to restore and improve the characteristics of the deteriorated cultural heritage materials and objects could be found in combination of cleaning procedures and appropriate protection systems. Commonly used cleaning methods are laser cleaning, latex/clay poultice method and biological cleaning. Cellulose powders and mixtures of cellulose fibres, clay materials and sand/light aggregate are well known and available on the market for the desalination. However, the composition of the commercial products does not modify in order to suit the individual properties of the substrates. With the intention to enhance the efficiency of the poultice, some variations of *textural properties of the clay support are needed.* Another criterion to be met for the effective desalination treatment is *the development of poultices in accordance with the state and properties of the cultural heritage sites* (chemical-physical nature of the material). Also, it is often needed to use more than one classic cleaning method and *combination of different cleaning* procedures. For the cleaning of mineral substrates (bricks, stones and concrete) of the chosen degraded objects, an innovative combination of the traditional desalination method (poultices). This kind of activation usually leads to the formation of a preferred structure: reduction of particle size, increasing of the specific surface, and formation of active sites due to the break-down of the crystalline lattice.
Despite growing number of investigations of nanocomposite coatings application in the field of cultural heritage protection, there are only few scientific studies that deal with the complexity related to the manufacturing of these materials (used in bulk or on the substrate surface) and their application on the porous building materials. The most commonly used value-added material is nano-sized TiO2, due to its high photocatalytic activity and stability. The nanosized TiO2 particles (<100 nm) can be immobilized onto support materials or preparing larger particles, i.e. agglomerates consisted of nano-sized units. Both proposed solutions retain nano particulate nature (high surface area, porosity, etc.) and thus inherit photocatalytic activity.
The design and development of the following new materials is planned:
• hierarchically structured TiO2 particles with a mezo porous microstructure and, consequently, a high

specific surface area, and
• coatings based on titanium dioxide impregnated into the activated clay support.

These innovatively formed systems will be studied in environmental catalytic processes, like self-cleaning function, applied on the chosen cultural heritage objects.

CONSOLIDANTS

It is known that the carbonate materials were treated by suspension of calcium hydroxide in water which however represents some obstacles especially in low penetration depth and incomplete conversion of lime to calcium carbonate that resulted in surface whitening and low consolidation efficiency. In order to overcome these problems, studies were focused to the synthesis of $Ca(OH)_2$ nanoparticles. Nanolime nanoparticles are typically produced by a chemical precipitation process in supersaturated aqueous solutions of the reactants (calcium chloride and sodium hydroxide). Similarly, the researchers dealt with several obstacles, such as incomplete carbonatization, agglomeration, varying in crystal morphology, wide size distribution of particles, etc. To improve the carbonization, alcoholic dispersion of nanolime particles with addition of baking soda solution has been prepared, which prevents the agglomeration and enhances the CO_2 content in dispersion. For instance, diminishing of water content with 2-propanol leads to the more complete carbonization and better size distribution. Some studies concerned synthesis and characterization of colloidal particles of $Ca(OH)_2$, where the effect of various synthetic parameters (T, concentration, addition of diols, concentration of the reagents, molar ratio,…) on the particles properties were studied. Since the previous calcium based consolidants show several deficiencies, such as small penetration depth (~1 mm), whitening of the surfaces, limited solubility, high alkalinity, high sensitivity to the humidity during the application, the need for an efficient consolidant for carbonate mineral substrates is of major importance. The main problem with already used calcium based consolidants is their low penetration and concentration due to low solubility of calcium carbonate in water.

In the field of consolidation of carbonate based historical materials the consolidants could be based on the soluble calcium carbonate compounds that during consolidation process form low soluble or insoluble calcium carbonate. The main advantage of the new consolidant proposed is deeper consolidation, where re-cohesion between the particles of deteriorated historic materials is established and compatibility with no whitening effect on the surface of the historic material is assured. Compared to other calcium carbonate forming consolidants, the newly developed consolidant exhibits greater strength of the consolidated material. Consolidant can be preferably used for consolidating mineral building materials. There is a need of better understanding the connection between the rate of consolidation, crystal growth, changing of crystal structure from amorphous to vaterite and finally calcite crystal structure and ageing at different conditions (temperature and relative humidity). There is also lack of appropriate methods for evaluation of consolidation efficiency in porous materials especially for non-destructive ones. In particular, there is a great need for the development of homogeneous model substrates to obtain reliable and appropriate information of consolidant efficiency, which is the great importance in the preservation of cultural heritage. These all are important subjects proposed to be carried out in the scope of the project. Furthermore, the developed consolidants will be modified and their usability will be tested also for consolidation of canvas and ground layer of easel paintings.

WP1.1 Immovable historic materials – characterization and degradation

- Research and recording of documentation of the selected sites
- Sampling and identification of degradation level of the cultural heritage objects on the selected sites
- Examination of the historic materials (brick, stone, mortar, wall paintings, render) with respect to the EU standards (invasive and non-invasive method of examination), petrophysical characterization of the materials: mineralogy, texture and study of the pore system
- Definition of the present mechanisms of degradations and raw materials, when used, for the manufacturing of the buildings constructive elements
- Preparation of the model substrates (samples)
- Simulation of the identified degradation mechanisms (ageing processes)
- Comparative characterization of aged and non-aged model substrates.

Materials characterization of the selected historical sites will serve as basic information for the formulation and preparation of model substrates.

Will be achieved:

- the characterization of historic materials, degree of deterioration, compatibility among materials;
- selection and characterization, preparation of model substrates, simulation of degradation and compatibility;

- characterization of historic materials;
- selection of historic materials;
- characterization of wall paintings of some historical monuments: paint layers: pigments and binders, painting technique, mortar layers, its degradation, preparation of model wall paintings and their characterization after ageing .

WP1.2 Movable historic materials – characterization and degradation

Materials characterization of lined and partially painted canvas from some old books from the 19th century includes:
- Research and recording of documentation of the artworks
- Sampling and identification of degradation of paper, ground and paint layers
- Simulation of the identified degradation mechanisms (aging processes)
- Parallel characterization of aged and non-aged model paintings

Materials characterization of paper artefacts from the some Collection dating from the 20th century:
- Identification of paper substrates with discoloration (yellowing, fading, darkening) and/or superficial deposit (dust, particles, greasy substances, additives, plasticizers)

RTD coordination with partners, characterization of movable artworks, research, recording documentation

Role of participants:

- characterization of the selected artworks,
- preparation of model, and their characterization after ageing;
- simulation of identified degradation mechanisms;
- characterization of the selected artefacts and preparation of paper substrates.

WP1.3 Advanced materials synthesis and characterization

Development of novel multifunctional materials for cleaning, consolidation and protection of mineral substrates:
- Synthesis, characterization and optimisation of novel materials: materials for **cleaning**, **consolidants** obtained based on chemical reactions and mixing procedures, while the **protective coatings** will be based on hierarchically structured TiO_2 particles with a mezo porous structure incorporated in mechanically/thermally activated clay materials and even hydroxyapatite and mixed apatite.
- Characterization of the novel materials: (a) cleaning and protective materials: morphology, structure and texture of synthesized powders and efficiency, density, viscosity, transparency, colour of the developed systems; (b) consolidants: efficiency, density, viscosity, transparency, rate of consolidation process and colour.
- Characterization of the consolidated and protected substrates prepared in the task WP1.1: functional properties (SEM/EDS), and consolidation efficiency by different methods (indicator method, DRMS, surface hardness, USV, FTIR and Raman microspectroscopy), colour change, durability-scratch and rinsing tests, water vapour permeability, water absorption and drying, antimicrobial efficiency, photocatalytic activity.
- Consolidation of the paintings (ground layers) will be based on the modification of consolidants
- Characterization of the consolidated model paintings prepared in the task WP1.2, including the development of methodology for testing the consolidation efficiency.

Task leader: progress of the newly cleaning and protective materials development, including synthesis and modification of new consolidants, characterisation of novel materials, characterisation of consolidated substrates

WP1.4 Compatibility and application of the advanced materials in laboratory conditions

- Definition of the compatibility criteria between the advanced and historical materials, determination of the most efficient techniques for the application of novel materials and investigation of their durability in the laboratory.
- The compatibility criteria definition will be accomplished by the investigation of physical, mineralogical and mechanical properties of the prepared substrates taking into account the previous experience and research activities in accordance with:
  - technological requirements due to methods of application
  - increase durability of the developed systems on the selected historical objects towards the action of chosen air pollutants
  - retreatability of the developed systems according to the protection of cultural heritage principles

Preliminary evaluation of the application technique will be based on results obtained on the model substrates. Detailed evaluation and selection will be made considering the predicted conditions on historical sites (temperature, humidity), best value for money (small residue) and environmental impact assessment will also be taken into consideration when choosing appropriate technique for application.

Role of participants: investigation of application methods and compatibility criteria considering the application of consolidants on wall paintings, evaluation and selection of the most appropriate technique for application of consolidants; water vapour permeability, compactness of materials; investigation of application methods and durability test; application of traditional and advanced analytical methods: SEM/EDS, FTIR, Raman, XRD, XPS, AAS, HPLC, Ion Chromatography and electrochemistry for the identification and characterization of organic binders from works of art.

WP1.5 NanoClay – Gel systems as Poultices in archive materials (books and papers) Conservation

The project propose to respond to some unsolved and serious preservation / restoration problems, offering solutions for current untreatable problems (cleaning, ink corrosion) and overcomes shortcomings in the existing processes. A new modular preservation process for the treatment of paper artefacts integrating elimination/prevention of ink corrosion by desulphatation, removal of former restoration residues combining the best currently available concepts with knowledge in nanotechnology.

The focus of this study was to determine how the use some clay nanosystems (Laponite, montmorilonite, and ion exchange resin gel) as a poulticing material. Different thickening agents including sodium carboxymethyl cellulose (CMC), were added into the clay-gel to minimize the lateral movement of the poultice in an effort to limit the development of tide lines. The clay- gel applied to aged samples of masking tape to illustrate the effectiveness of the poultice on modern adhesive tapes. Also, the aim of this project was to determine whether a residue would remain on paper and parchment substrates treated with a Laponite poultice.

Laponite and similar clays are synthetic inorganic clay of very small particle size that disperses in water to form a thick, thixotropic, colloidal gel. They will be used as a poultice in the conservation of books and parchment to remove dirt and adhesive residues and to stop the ageing processes. The process will be transferred from the laboratory to the archive scale, including construction and production of test devices. Some new patents will be achieved preserving the project idea and the solutions offered by this project.

Project targets:

- To preservation of archive materials (books and papers) combating the deterioration of its mechanical properties by acidic processes, light degradation using the latest developments in cellulose chemistry and nanotechnology.
- To develop a new modular preservation process for the treatment of paper artefacts integrating elimination/prevention of ink corrosion by desulphatation, removal of former restoration residues combining the best currently available concepts with knowledge in nanotechnology.
- To develop an integrated process to save and protect biomaterial based artefacts (books, papers), from acidic degradation, reduction in mechanical strength, ink corrosion;
- To develop the preservation, the protection and the control process as well as the needed chemical compounds, instruments and machinery to a prototype stage in cooperation between the academic and industrial partners;
- To perform large scale test treatments in cooperation with end users and to disseminate the knowledge via end user associations, by patents the main discoveries and to protect the ideas;
- To propose, based on the results, a strategy to transfer these processes and devices into marketable products.

(Rodica Ion)

Deliverables

(Bondioli Federica)

The expected results as far as the technological innovation is concerned are the following:

1. Nanoparticulate films for historic stones:

i) optimization of a sol-gel process for hard coating with functional properties like reinforcing, antibacterial, depolluting and autocleaning for historical stones so as to meet the conservation and compatibility requirements for Cultural Heritage (sympathetic conservation); M12

ii) deeper understanding of the correlations among roughness, microstructure and photocatalytic/antibacterial properties; M18

iii) durability performances of this coating; M24

iv) LCA analysis to objectively evaluate the environmental and health effects of the innovative products/process developed in this study. M36

2. Nanoparticulate films for the protection of paintings:

i) optimization of a protective coating for historical painting so as to meet the conservation and compatibility requirements for Cultural Heritage (sympathetic conservation);

ii) durability performances of this coating;

iii) LCA analysis to objectively evaluate the environmental and health effects of the innovative products/process developed in this study.

(Bondioli Federica)

(Rodica Ion)

D1.1 – Report of historical materials characterization on immovable historical objects and movable artefacts, M12

D1.2 – Report of model substrates before and after degradation procedures, M24

D1.3 – Efficiency of developed cleaning materials, protective coatings and consolidant formulations in laboratory, M24

D1.4 – Report of developed consolidant formulations for their laboratory application on artefacts, M24

(Rodica Ion)

Code 7 (All Partners received empty templates for Work packages WP2, WP3, and WP4; please, any Partner should return these templates to** each2014@gmail.com **compiled as a first draft).

Table 3.1a: Work package WP5 description

Work package number five		**Start Date**					
Work package title	**Project results diffusion**						
Participants number							
Short name							
Pearson/months per Participant:							

Objectives

Objectives if this Work package are

1 - Dissemination and exploitation of results

Definition of a work plan for dissemination and exploitation of the project results; implementation of a social platform

2- Communication activities

Organization of events concerning the partners of the Consortium; preparation of a website; organization of mid term workshops and final conference open to EU Commission experts

Description of work

This Work package aim is to improve the dissemination of information about the project results and deliverables: it is a core measure of the project's success. According to this preliminary consideration, different promotion and dissemination actions are foreseen and addressed to both experts in the field and any other Stakeholders.

1 - Dissemination of project results through scientific journals and through participation in Congresses, conferences and workshops

All project results will be shared and disseminated among the project Partners. In order to ensure high visibility of the project within the scientific community, publication in high impact factor scientific journals will be encouraged, as will be presentation at relevant workshops and conferences. Each research institution in this proposal will contribute to this dissemination as participants in WP 5.

2 - Organization of a workshop and a conference

In particular, within six months from the starting of the project a workshop will be held open to specific stakeholders.

3 - Demonstration event. In close collaboration with the WP2, WP3 and WP4 teams a demonstration event will be arranged in order to show how the newly developed techniques work.

This will exhibit the validity and usefulness of the new tools to a competent audience, able to comment and discuss the results obtained.

4 - NATECH Website. Promotion of the demonstration event will be made through this website.

Other activities:

1 – Organization of the partners consortium meeting before and throughout the project activity according to the Coordinator suggestions (for 24 months); application of tools and methodologies of risk management to the governance of single parts of the project according to the suggestions of the project coordinator.

2 - Dissemination and exploitation of results deliverables, elaboration of a website concerning the activities of the project; maintenance and adjournments of the website during and after the project preparation; organization of events.

3– Project internal communication of documents and deliverables among the project partners

Deliverables

- Workshop and conference in and related information & dissemination material
- Papers in scientific journals
- Launch of fully functional Knowledge Base
- Demonstration even
- Commercial service development
- Business Plan for exploitation of products and services

Next Table 31b shows the list of work packages:

Code 8 (to be written once Work packages are ready)

TABLE 3.1b – List of Work packages

Work Package No	Work Package Title	Lead Participant No	Lead Participant Short Name	Person-Months	Start Month	End Mo nth
One						
Two						
Three						
Four						
Five						
				Total months		

Next Table 3.1c shows the list of Deliverables for each Work package:

Code 9 (to be written once Work packages are ready)

TABLE 3.1c – List of Deliverables

Deliverable (number)	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date
		One				
		Two				
		Three				
		Four				
		Five				

3.2–Management structure and procedures

In order to efficiently manage the project, a specific WP dedicated to coordination and management has been foreseen in the project work plan, to ensure that suitable priority and attention will be given to project management. Within this WP 1 all the aspects related to administrative and quality management of the project will be included. The responsibility of the project coordination will be taken by XXX that will supply the Project Coordinator (PC) and a Project Officer (PO).

The project partners are fully committed and agree to work together with the utmost cooperation for the timely fulfilment of their responsibilities. Previous experiences and participations in European framework programs have led to the decision to keep this management structure as simple as possible. The **overall organizational structure** proposed for the NATECH project is presented in Figure 1. It is aimed at ensuring the fulfilment of the project objectives, by allowing clear and continuous communication among the project partners.

a) Project Coordinator

The overall management of the project will be the responsibility of XXX as coordinating partner. Key to this is the role of the Project Coordinator, which will be carried out by ……….

The **Project Coordinator** (PC) will be responsible for the **overall coordination** of the **technical and scientific activities, and all other aspects of the project** including **management of potential conflicts** and compromise negotiation in the unlikely event of conflict and will also be the primary contact person for the European Commission. Hence he/she will be responsible for all communication with - and reporting to - the EC.

The **Project Officer** (PO) will be responsible for day-to-day **legal and contractual management** of the project and **administrative and financial activities.** The PO will report to the PC.

In particular, according to the Consortium Agreement, the Coordinator shall be responsible for:

- Monitoring compliance by the Parties with their obligations
- Keeping the address list of Members and other contact persons updated and available
- Collecting, reviewing and submitting information on the progress of the project and reports and other deliverables (including financial statements and related certification) to the Funding Authority
- Preparing the meetings, proposing decisions and preparing the agenda of General Assembly meetings, chairing the meetings, preparing the minutes of the meetings and monitoring the implementation of decisions taken at meetings
- Transmitting promptly documents and information connected with the project
- Administering the financial contribution of the Funding Authority and fulfilling the financial tasks
- Providing, upon request, the Parties with official copies or originals of documents which are in the sole possession of the Coordinator when such copies or originals are necessary for the Parties to present claims.

The following Table 3.2a gives a list of milestones.

Code 10 (to be written once Work packages are ready)

TABLE 3.2a – List of milestones

Milestone number	Milestone name	Related work package(s)	Estimated date	Mean of verification

The following Table 3.2b gives the critical risks identified and the possible mitigating actions.

Code 11 (to be written once Work packages are ready)

TABLE 3.2b – Critical risks for implementation

Description of risk	Work package(s) involved	Proposed risk-mitigation measures

b) The General Assembly

The General Assembly is the decision making body of the Consortium.
The General Assembly shall consist of one representative of each Party (hereinafter referred to as "Member").
Each Member shall be duly authorised to deliberate, negotiate and decide on all matters listed in the Consortium Agreement.
The Coordinator shall chair all meetings of the General Assembly, unless decided otherwise by the General Assembly.
The Parties agree to abide by all decisions of the General Assembly.
This does not prevent the Parties from submitting a dispute for resolution in accordance with the provisions of settlement of disputes.
Operational procedures for the General Assembly representation in meetings
Any Member:

- should be present or represented at any meeting;
- may appoint a substitute or a proxy to attend and vote at any meeting;
- shall participate in a cooperative manner in the meetings.

c) The Work Package leaders

All technical and scientific issues of the project, in particular relating to the interdependence between and coherence of the different WPs - will be managed and consolidated by **the Work Package leaders** who will **report to the PC directly**. To achieve the R&D objectives of the project, the experimental, scientific and technical work has been organized into 3 R&D WPs (WP2,WP3, and WP4).
For each of them, a WP leader will be appointed to take primary technical control of and responsibility for the proper management and execution of the tasks related to the particular WP. In particular, he/she establishes (in coordination with the PC) the detailed schedule of his/her WP and the work in progress. Each WP leader is also responsible for identification of risks and for proposing solutions to the PC in respect of his/her WP. Taking into account that any of these R&D WPs will be the responsibility of three/four partners, WP leaders will be rotated among partners any four months.
Each WP leader is required to provide the PC at four monthly intervals with a progress report concerning his/her WP and containing sufficient technical information to enable the PC to be assured that work is progressing according to plan.

d) Means for governance and control

The means for governance and control (quality assurance, consortium agreement and communication plan) will be tailored to the scale of the NATECH project. A correctly empowered governance and control for the overall project management will be guaranteed by following means:
The Consortium Agreement: All the NATECH rules will be included and described in detail in the **Consortium Agreement**.
This document will define:
- the responsibilities, mutual obligations and roles of the partners;
- the division of the budget;
- the strategy for the exploitation of results;
- the rules for the settlement of disputes

The Consortium Agreement will be signed within the first month of the project and will define in a very clear and detailed way: roles of each partner, formal rules of participation, voting mechanisms, criteria for evaluation of activities realized by each partner, rules for budget re-allocation, etc.
The Quality Plan: A **quality plan** will be agreed by the General Assembly at the Kick-off meeting, and will ensure that appropriate quality assurance is undertaken. It will include:
- persons responsible for quality assurance, quality standards, methodologies and procedures;
- procedures for identification, distribution, collection, filing, maintenance and disposal of quality records resources, schedule and responsibilities for conducting the quality assurance activities

Quality control will represent a key issue in the overall management of the project, since it plays a critical role in keeping the action aligned towards its final objectives.

d) Project Meetings

An initial „launch/kick-off meeting will be organized at the start of the NATECH project for all the personnel involved in the project. The purpose of the kick-off meeting is to:
- Present to all involved an overview of the project;
- Enable each participant to obtain a better perspective of his/her role in the NATECH project and set this in context with the roles and skills of other project members;
- Define the main outline of the Consortium Agreement;
- Establish procedures for Quality Assurance and formalize policies for publication, intellectual property rights and any arbitration procedures.

3.3 –Consortium as a whole

Partners of the Consortium will be all the partners working on the five Work packages. Each partner will designate a member to participate to the meetings of the Consortium.
All the rules reported in the EU suggested Consortium Agreement must be followed.
The Consortium partners belong to very different scientific disciplines, from IT engineers to archaeologists, from robotics and mechanical experts and they have to complement one another in order to create a Robotic System suitable for this project.
Analogously, the presence inside the Consortium of Enterprises is fundamental for building and experimenting the products of project.
The NATECH project is proposed by a consortium of xx **partners** from **X EU Member States** and comprises all the appropriate key players to ensure the availability of resources, capacities, technologies, capabilities, technical and operational knowledge required for the timely achievement of the goal of the project.
The consortium will bring together European efforts and methodological/technological developments and has therefore a high potential for developing and validation of innovative non-destructive diagnosis techniques to assess and monitor the state of preservation of the European heritage.

The partners to the NATECH project have the following areas of interest and activity, Table 3.3.

Code 12 Any Partner should send these data by mail to each2014@gmail.com; please only one sentence!)

Table 3.3 Areas of interest/activity for NATECH project partners

P	Area of interest / activity

3.4 – Resources to be committed

Code 13 (Section 3.4 to be written only after all other points and sections are ready)

According to costs as stated in the budget table in Part A of the Proposal, the following Table 3.4.1 shows the costs distribution.

Table 3.4.1 Total Costs

	WP 1	WP 2	WP 3	WP 4	WP 5	Total
Personnel costs						
Other costs						
Total direct costs						
Indirect costs						
Subcontracting						
Total costs						
Requested subsidy	2					

In order to achieve the objectives of NATECH, duration of 24 months has been foreseen for the project. The overall project cost is € xxx.xxxx and **the overall EU contribution requested is € xxxx.xxx**, both reasonable and necessary considering the number of partners, the ambitious objectives and the duration of the project.

In the following, more details are provided about the costs in the main cost categories of the project.

3.4.1 - Personnel Costs

Personnel costs represent a significant part of the project budget, in total **€ xxxx.xxx**. For each work package, the personnel costs have been calculated considering the appropriate man-power (see Table 3.4 a – Summary of staff effort) needed to complete the proposed activities.

TABLE 3.4a – Summary of staff effort

	WPn	WPn+1	WPn+2	Total Pearson/ Months per Participant
Participant Number/Short Name				
Participant Number/Short Name				
Participant Number/Short Name				
Total Person/Months				

The weighted average monthly rate costs of the personnel that will be working in the work package are provided in Table 3.4.2

Table 3.4.2 – Weighted average monthly personnel costs in € per partner and work package

Partner	W	W	W	W	W

Next Table 3.4b shows "other direct costs" for participants where those costs exceed 15% of the personnel costs.

TABLE 3.4b – "Other direct cost" items

Participant Number/Short Name	Cost (€)	Justification
Travel		
Equipment		
Other goods and services		
Total		

3.4.2 - Travel costs (other direct costs)

The total travel costs are **€ xxxx** and refer to meeting, working session and other issues related to the coordination of participants' contributions, as well as to the attendance of conferences and events for dissemination purposes. In more detail, the following travels have been foreseen, so far, for calculating the travel costs:

- ***Project meetings***: technical and management meetings where all participants will be present, and where technical issues as well as management issues will be discussed. 6 project meetings are foreseen for the project duration (one meeting each 6 months of project).
- ***Technical meetings***: meetings needed among two or more partners collaborating on the same tasks. The twice yearly Project meetings will form a significant venue for inter WP discussions, and will make provision for specific subsets of WP managers to meet outside the main workshop on request, e.g. for inter- and intra-WP decision-making purposes.
- ***Dissemination meetings*:** participation to international conferences/workshops to present the NATECH results, and for attendance to the NATECH workshop. Each participant involved in WP5, will receive travel costs.

3.4.3 - Consumables (other direct costs)

The total costs for consumables amount to **€ xxxxx**.
The consumables with NATECH are mostly related to preparation, analysis, characterisation, validation, process optimisation, pre-prototype development and tests and are summarized in table 3.4.3

Table 3.4.3.a – Consumables per work package

	Consumables description

A total of **€ xxx** has been included for the purchase of durable equipment by the project partners. The equipment costs were calculated on depreciation basis, considering the duration of usage of the equipment within the project. The table 3.4.3.b provides an overview of the planned equipment purchases

Table 3.4.3.b – Equipment purchase per participant

rtner short na me	V a l u	E l i g	Description	W P

3.4.4 - Other costs (other direct costs)

The other remaining costs amount to **€ xxxx**. These are listed in Table 3.4.4

Table 3.4.4 – Other direct costs per Work package

	Other costs

4 – Members of the Consortium

Code 14 (All Partners, starting from now, should write at least about three pages plus the relevant publications lists, concerning both the Organizations they belong to and the persons who will carry out the proposed activities)

4.1 – Participants

- A description of the legal entity and its main tasks, with an explanation of how its profile matches the tasks in the proposal;

(Perkiomaki Kirsi)

Helsinki Metropolia University of Applied Sciences (Metropolia), operating in the Greater Helsinki Area, is the largest university of applied sciences in Finland. Metropolia trains experts and developers in the fields of culture, business, health care and social services, and technology. Metropolia's turnover in 2015 is 103 M€

Metropolia is specializing in developing new practical innovations, operating surroundings and building knowledge based networks with close co-operations with companies, industries and with other social and cultural operators and societies. Metropolia is a responsible partner and reformer of the higher education, cooperating to find new solutions and to build a better future.

Metropolia offers students an international and stimulating environment for learning with close connection with enterprises. All curricula have been reformed to meet the challenges of rapidly changing work life. All four education fields offer both Bachelor and Master level programs in Finnish and in English.

Degree Programme in Conservation (Sustainable Processes and Materials Department) offers Bachelor's degrees and Master's degrees in Conservation in six specializations:historical interiors, paper, textile, furniture, painting and cultural historical objects conservation. The four-year bachelor's programme is currently the only Degree programme in Finland and hosts 60 students and 9 staff members. We have modern teaching and laboratory facilities and possibility to cooperate with our Material Technology and Surface Engineering laboratory.

Conservation is an interdisciplinary area of science. The purpose of conservation is to preserve our cultural heritage. Conservation includes all such actions, which slow down and prevent the deterioration of cultural heritage. Conservation can be divided into technical and preventive conservation.

The education is based on manual skills and extensive theoretical, technical and scientific education. Documentation, including material analyses, analytic photography, condition surveys and understanding cultural and art historic contexts are an essential part of conservation. Full conservation reports will be resulted after the conservation of objects. Creativity is also an essential part in solving conservation problems.

The Degree Programme in Conservation provides the preparedness to work as a conservator, the specialist responsible for the protection and conservation of the cultural heritage. The aim is to be able to independently solve conservation problems. Conservators are working as experts protecting world and national cultural heritage in wide sectors – museums, archives, libraries and in various projects. The education also gives possibilities to work as entrepreneurs.

Helsinki Metropolia University of Applied Sciences (Metropolia) has extensive experience in project work. During previous years Metropolia has coordinated and participated in several European research programmes,such as ERASMUS IP, Leonardo da Vinci, FP6, FP7, COST, Life and CIP.

(Perkiomaki Kirsi)

- a curriculum vitae or description of the profile of the persons, including their gender, who will be primarily responsible for carrying out the proposed research and/or innovation activities;

(Perkiomaki Kirsi)

Amar Mahiout, Project Manager (M.Sc. Tech.) has more than 30 years' experience in material science and surface engineering. He has also previous experience in management, coordinating of large national and international EU projects.

Kirsi Perkiömäki, Senior lecturer (M.Sc. Chem.) in Sustainable Processes and Materials Department, Degree Programme in Conservation, Metropolia. In her studies she has specialized on analytical chemistry.She has 10 years experience in teaching the chemistry of conservation and related materials. She has participated in several research projects on international and national level mostly concerning the use of chromatographic systemsfor monitoring aqueous conservation treatments.

Krista Hackzell, Laboratory assistant (M. Sc. Chem),Working as a laboratory assistant in Conservation Department laboratory. She is a graduated chemist from the University of Eastern Finland, where she specialized in material chemistry with a particular emphasis on polymers. She have done research in the field

of biochemistry and chemistry in the academic world.
She has been working in different kinds of material projects where the main idea have been to prepare hydrophobic polymer coatings. In one of the projects hydrophobic silica nanoparticles were used to change the surface structure.
Her bachelor thesis name was "Investigation of plasma-surface modification of polyacrylate coatings". In this investigation she used SEM-EDS and contact angle measurements for evaluation of the coatings/surfaces.
(Perkiomaki Kirsi)

(Sabbatini Luigia)

WP2: Diagnostic with Nanosystems/Nanodevices	
Name – Institution - Country	**Role – Research activity**
PALADINI Alessandra (CNR-ISM, Italy)	development of a portable Raman spectrometer and development odnanosystems for SERS
SISTACH Carmen (Archive of the Crown of Aragon, Spain)	development of nano-devices for air pollutants monitoring (indoor, library, museum, caves…)
SMOLIK Jiri (Institute of Chemical Process, Czech Rep)	analysis of air pollutants by traditional approach in confined environment (indoor, library, museum, caves,…). *This activity could be useful to validate the nano-device (sensor) developed by SISTACH*

WP3: Restoration by Nano-systems	
Name – Institution - Country	**Role – Research activity**
IOANNOUIoannis (University of Cyprus)	design, lab production and characterization of nano-modified (using SiO2 and TiO2) lime-based plasters
ION Rodica-Mariana (ICECHIM, Romania)	cleaning procedures based on nanostructural gels (micelles and nano-emulsions or other nano-systems); tailored nano-productsCa(OH)2, Sr(OH)2, Ba(OH)2, hydroxyapatite and its metallic derivatives, as consolidants of suitable carbonated substrates (marbles, chalk stone, etc.)
POLCARO Chiara (CNR-IMC, Italy)	nanosystems for wood restoration/consoldation????
SANDAK Anna (CNR-IVALSA, Italy)	nanosystems for wood restoration/consolidation ????
PERKIOMAKIKirsi	**???? Role to be defined**

WP4: Conservation by Nano Systems	
SABBATINI Luigia (University of Bari Aldo Moro, Italy)	Development of nanostructured composites (polymer/nano Cu, polymer/nanoZnO, TiO_2…) with biocide activity for stone conservation (prevention of biofilm formation/ ricolonization)
POLLIO Antonino (University of Napoli Federico II, Italy)	Development of protocols for the growth of model biofilms in order to test bioactivity of innovative nanostructured materials
PANGALLO Domenico (Slovak Academy of Sciences, Slovakia)	Developmentof different agar tests to screen the various biodegradative abilities of isolated microflora against several natural and synthetic polymers (i.e., matrices of nanocomposites)
CALIA Angela (CNR-IBAM, Italy)	Investigation of the interaction between polymers and stone substrates; in particular, how stone's characteristics influence its response to the application of conservation products
IOANNOUIoannis (University	Development of coatings (NANO??) for stone monuments

of Cyprus)	conservation. Study of their properties (e.g. depth of penetration, effect on pore structure etc.); durability tests (e.g. salt crystallization studies)
ION Rodica-Mariana (ICECHIM, Romania)	NanoClay – Gel systems as poultices in archive materials (books and papers) conservation
BONDIOLI Federica	Investigation of photocatalytic activity of TiO_2 on stone substrates; influence of aging and substrate characteristics on photocatalytic efficiency.
AGOSTIANO Angela (University of Bari Aldo Moro, Italy)	TiO_2nanocrystaldesign, synthesis and characterization; functionalization of photoactive nanocatalysts finalized to their incorporation in hybrid matrices.
CASALETTO Maria Pia (CNR-ISMN, Italy)	Nano-structured Coatings for corrosion onhibition of metal artifacts

Ortiz Pilar, Universidad Pablo de Olavide, Spain ????? Role to be defined
(Sabbatini Luigia)

- a list of up to 5 relevant publications, and/or products, services (including widely-used datasets or software), or other achievements relevant to the call content;

- a list of up to 5 relevant previous projects or activities, connected to the subject of this proposal;

(Perkiomaki Kirsi)

Mahiout, A., Siivinen, J., Mannila, J., Mahlberg, R., Nikkola, J., Romu, J., Ilola, R., Söderberg, O., Virtanen, J., Pehkonen, A., Katajarinne, T., Kivivuori, S., Koskinen, J., Hannula, S.-P.
Added –value for new metal products by hybrid coatings. VTT Research Notes 2517. ISBN 978-951-38-7547-3.

13. - 15.4.2011 ART´1110th International Conference, Non-destructive investigations and microanalysis for the diagnostics and conservation of cultural and environmental heritage, Florence, Italy.http://www.aipnd.it/art2011/
Diagnostic NDT AND Micro Analyses of the Fresco"Kullervo Departs for the War", 1901 By Akseli Gallen–Kallela,
A.Koho, K. Perkiömäki, M. Seppäläand U. Knuutinen

5th International Congress "Science and Technology for the Safeguard of Cultural Heritage in the Mediterranean Basin" 22nd – 25th November 2011, Istanbul, Turkey, http://www.istanbulcongress2011.com/
B1.30Developing Applications of Ion Chromatography for Aqueous Conservation Treatments of Cultural Heritage Artifacts
Ulla Knuutinen ja Kirsi Perkiömäki Helsinki Metropolia University of Applied Sciences

Metropolia is interested to participate workpackages three or four.
We have good abilities to connect the research of materials to the use conservation/restoration methods. In Metropolia we can arrange the research of the properties of materials and also test the materials and treatments with real objects. In our Material Technology and Surface Engineering laboratory it is possible to prepare nano-structured films and also evaluate their properties for example by SEM-EDS and contact angle measurements.
(Perkiomaki Kirsi)

- a description of any significant infrastructure and/or any major items of technical equipment, relevant to the proposed work;

(Perkiomaki Kirsi)

Resources of Metropolia and tests facilities:

Metropolia offers services ranging from material surface characterization and corrosion control to the development of coatings and Nano-materials for diverse industries.
The facilities at Metropolia include the following: *Surface treatments facilities*: chemical, painting and electrochemical depositions.
Analytical facilities: Elcometer coating thickness gauge (for ferrous/nonferrous substrates), UV-VIS spectrometer; FTIR (microscope ATR), EDXRF and contact angle device. Metropolia is capable of providing its clients with thorough materials analysis using Scanning Electron Microscopy coupled withEnergy Dispersive X-ray Spectroscopy detector (SEM-EDS).

(Perkiomaki Kirsi)

- any other supporting documents specified in the work programme for this call.

4.2 – Third parties involved in the Project

No third parties involved in this project

5 – Ethics and Security

5.1 – Ethics

There is no ethics issue in the ethical issue table in the Administrative Proposal Form of NATECH, Part A.

5.2 – Security

The activities or results of this project do not raise security issues.