

Topic

HORIZON-CL2-HERITAGE-2021-01-01: Green technologies and materials for cultural heritage

Topic	Budget (EUR) - Year : 2021	Stages	Opening date	Deadline
HORIZON-CL2-2021-HERITAGE-01-01 - HORIZON-RIA HORIZON Research and Innovation Actions	12 000 000	single- stage	22 June 2021	07 October 2021

Scope

Materials and methods for the conservation and restoration of cultural heritage have been researched, with less energy consuming, environmental friendly, not harmful for the health of operators and curators, durable and sustainable. More materials and new tailored solutions have to be addressed to match the Green Deal objectives, taking into account the citizens' health and safe for the operators and the artefacts. The scope includes buildings, monuments and artefacts belonging to cultural heritage.

AIDIMME

AIDIMME is the Metal-Processing, Wood, Furniture and Packaging Technology Institute. A technology centre that fosters the competitiveness of the companies of the mentioned industries through research and innovation activities and its key competences are in Cultural and historic heritage preservation; Bio-based materials; Advanced application of materials; Modified surfaces; Industry 4.0; Treatment of water and waste; Additive Manufacturing; Product Development and Optimization; Toxicity of materials, Packaging Systems; Chemical Technologies; Process and Sustainability; Circular Economy; Socio-economic research; Testing laboratories. ⁱ

Below it is a description of how AIDIMME could contribute to this topic:

EXPECTED OUTCOME	AIDIMME CONTRIBUTION	AIDIMME EXPERIENCE	Equipment more relevant
To develop methods to conserve, preserve and restore monuments and artefacts using materials in a sustainable, green way	To develop coatings based on non-toxic and bio-based materials with advanced functionality for protecting monuments and artefacts: waterproof, fire flame retardant, biocide, UV radiation, capture of harmful gases ...	Research projects to develop coating with advanced properties (hydrophobic, biocide, increased wear behavior, flame retardant, ...) ⁱⁱ	Laboratory for reaction to fire tests Laboratory for the development of coatings with advanced properties using the solgel technique and pilots for their application. Atmospheric plasma to change surface energy. Contact angle equipment to measure surface energy. Microbiology laboratory to evaluate the biocidal capacity. Chemical equipment to analyze toxic components of materials (IR, HS-GC, HPLC, ICP, ...) Chambers to measure air quality.

	Consolidation of wooden and concrete structures using recycled and/or bio-based materials	<p>Research projects dealing with new methods to improve damaged wooden structures using recycled and bio-based materials ⁱⁱⁱ</p> <p>Research projects to improve concrete by recycled fillers ^{iv}</p> <p>Diagnosis and consulting tasks for building restoring</p>	<p>NDT equipment for mechanical strength</p> <p>Traction, compression, flexion equipment for beams and similar elements</p> <p>Thermic conductivity equipment</p> <p>Equipment to measure useful properties for construction elements: longitudinal stability, vapor resistance ...</p>
Research on quality of conservation, leading to a more sustainable and green maintenance and restoration	<p>To develop schemes to carry out optimized maintenance, through appropriate data compilation</p> <p>Monitoring of degradation of materials and construction elements.</p> <p>To develop sustainable pre-fabricated elements to improve conservation and maintenance with low on-site operation.</p> <p>Use of digital twins to simulate efforts and increase behavior of real element.</p> <p>Use of AR/VR for developing a virtual replication of the artefact/building and for creating mixing reality environments.</p> <p>Use of additive manufacturing for repairing and restoring some elements and artefacts. The materials to be considered could be metal alloys such as steel, copper, aluminum among others; and different polymers such as</p>	<p>Research projects to monitor materials and elements degradation ^v</p> <p>Patents for sensors to monitor wood biodegradation due to moisture and xylophages</p> <p>Application of these sensors in real sites (Mallorca, Valencia, Palencia, Ávila, ...), most of them belonging to heritage</p> <p>Project to develop environmental friendly prefabricated elements to be used inside and outside (bio-based materials, recycled materials, geopolymer, ...) ^{vi}</p> <p>Collaboration with architects to find the optimized restoration and maintenance method to be applied in real buildings</p> <p>Tasks in standardization working groups: paints, wood based materials, smart cities ...</p> <p>Research on digital twins and VR/AR solutions for different</p>	<p>Sensors to measure CH₄, CO₂, light and moisture content related to xylophages</p> <p>Alarm system for xylophages apparition</p> <p>Chambers where simulate different agents occurring in construction, at laboratory and pilot scale</p> <p>Hot plates press to build sandwich elements, at pilot scale.</p> <p>Pilot plant for digital twins and VR/AR. Showroom and demo environments.</p> <p>Additive Manufacturing in metals: different technologies based on powder bed fusion (laser and electron beam).</p> <p>Additive Manufacturing in polymers: different technologies for processing resins and thermoplastics such as SLA, DLP, SLS, CFF, and MJF. Also vacuum casting for producing replicas.</p> <p>3D scanners for</p>

	polyamides, resins, among others.	applications. Research projects on Additive Manufacturing at national and European level. ^{vii}	obtaining the 3d model from a real object.
Strengthen citizen's contribution	Training Diffusion Guide of good practices Implementation on rural and uninhabited areas	Training department where technicians teach about several materials to different kind of attenders: academic, workers ... Contact with different communication media Realization of guides of good practice to different subjects: how to build a safe furniture, MDF for food contact ...	

Other issues to consider, in which AIDIMME could contribute:

- Possible contribution to relevant platforms of the Joint Research Centre (JRC) in terms of data, indicators and knowledge by means of the monitoring systems and digital twins.
- Life cycle assessment (LCA) and the environmental footprint method.
- The use of digital and cutting-edge technologies by means of monitoring systems, digital twins and additive manufacturing.
- An active and sustainable engagement with stakeholders, social innovators and citizens by means of a network based on historic activities. AIDIMME could provide different stakeholders to the Consortium depending on the requirements.
- The active involvement of local, regional or national authorities and sectoral social partners, particularly in the uptake and implementation of research results and recommendations by means of a network based on historic activities. AIDIMME could provide different stakeholders to the Consortium depending on the requirements.
- A clear strategy for the uptake of research outcomes, recommendations or results, in particular where CCIs are participating or are concerned by means of a specific R&D exploitation department. AIDIMME has a close relationship with SMEs which could exploit the outcomes.
- Training and education activities for targeted groups of users and/or stakeholders by means of a specific training department.
- A robust plan for how projects will use or build on outputs and results from research already undertaken and technology already available by means of a specific R&D exploitation department.
- Increased participation of CCIs, SMEs and industry by means of a network based on historic activities.

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ⁱ In the area of Cultural and Historic Heritage Preservation, the following research groups are mainly involved:

Wood Technology and Biotechnology Research Group

With more than 25 years of experience, the team expertise includes:

- Research on wood protection (new wood treatments and modifications, paints, varnish, coatings, nanotechnologies, etc.) on both timber constructions and wood-based products.
- Non-destructive evaluation of old timber in construction: wooden beams and columns, structures, and historical heritage.
- Innovative reinforcement and repair of old timber elements: wooden beams and columns, structures, and historical heritage.
- Remote and automatized monitoring of timber elements, structures, historical heritage buildings and artworks by using wireless sensors and IT/Smart City technologies.
- Testing of wood and wood-based products against termites, xylophages, moisture damages and others wood deteriorating agents.
- Biocides efficacy tests on wood preservatives
- Quality control during building and structure execution.
- Innovation on timber architecture: organic structures, parametric architecture, new materials (reinforced timber, lightweight panels, etc.), temporary structures, and joints.
- Detection and handling of xylophagous fungi and insects such as in termites' detection and handling since the Mediterranean area has a high activity of those insects.

The facilities include: A microbiology laboratory and an entomology laboratory full equipped with all type of chambers and impregnation autoclaves; Devices for non-destructive evaluation of wood; Sensors for remote monitoring of wood; Environmental laboratory fully equipped; Different termites colonies (*Reticulitermes* spp.) kept in laboratory conditions for its studies and research.

The Raw Materials Research Group

The team is composed by a multi-disciplinary technical team that includes chemists, biologist, chemical engineers, forestry engineers and physicists. This group is more than 30 years in a close relationship with the industry focusing its activities on providing solutions to the industry needs and requirements and also on giving support to the industry to become more competitive and innovate through technological advances.

The group has carried out research in different materials such as wood, wood-based materials, panels, resins, coatings, foams, fabrics, fittings, metallic parts, plastics...

Additionally the group is actively involved in standardisation activities, having expert members and coordinators in CTN (Spanish committees), CEN (European committees) and ISO (international committees).

Some examples of research activities carried out by this group in the last five years are: Development of fire-resistant and damp-resistant materials and products; Improvement of adhesive and resin properties; Reduction of formaldehyde emission in wooden components; Development of biodegradation resistant materials and products; Improvement of solid wood and wood based boards by different techniques; Optimisation of paints and varnishes used in different sectors; Development of innovative technologies for the surface treatment and finishing of wooden composites.

The group also participates in different standardization committees, among others:: AEN/CTN 112 "Corrosión y Protección de los Materiales Metálicos". CEN/TC 262 "Corrosion and protection of metallic materials"; ISO/TC 107 "Metallic and other inorganic coatings"; ISO/TC 156 "Corrosion of metals and alloys; GT3 Jewelry and horology; ISO/TC 114 "Horology" SC 06 "Precious metals coverings"; CEN/TC 139 "Paints and varnishes"; ISO/TC 35 "Paints and varnishes"; ISO/TC 135 "Non destructive testing" ; AEN/CTN 48 "Paints and Varnishes; CEN/TC 139/WG 2 Coating systems for wood; ISO/TC 79 SC2 "Organic and anodic oxidation coatings on aluminum"; AEN/CTN 56 de "Wood and cork"; AEN/CTN 57 de "Cellulose and paper"; Sectorial group for the European Normative of Construction goods SG 20 "Wood based panels";

AEN/CTN 23/SC 6 “Security against fires. Tests of materials reaction against fire”; CEN/TC 127 Fire safety in buildings WG 4 Reaction to fire.

ii List of research projects:

- NANOLASUR. Development of nano-technologic and new water-based lasurs with high behaviour for wooden elements to be used outside, IMPIVA 2011-2014.
- Development of nano-technologic auto-cleaning coating for different substrates IMPIVA, 2008-2009
- Research and development of new added-value hydrophobic materials for furniture sector, using nanocomponents IMPIVA. 2008-2010.
- NANOMECH. Research on new coating formulations with high mechanic properties using nano-additives IMPIVA 2010-2011.
- Paints and varnishes formulated with biocides for wooden, IMPIVA 2006-2008.
- NANOSURF – Surfaces modification techniques for polymeric, metallic, wooden, textile and ceramic substrates by nanotechnology, IVACE 2014-2015.
- FUNGISTOP – Development of paints with antifungal properties using bio-based biocides, IVACE 20-21
- MESOGEL – Antimicrobial coverings nano and meso structured for prosthesis using anodized and sol-gel coatings, IVACE 20-21
- RICORR – Coatings added with indicators for corrosion, IVACE 20-21
- WALL4WOOD – Improvement of dimensional stability, wooden durability and fungus prevention using hydrophobic coatings, IVACE 20-21
- ANTIBACTERIANO – Development of antimicrobial surfaces using coatings formulated with natural and sustainable biocides, IVACE 19-20
- PROTEGEL- Development of antimicrobial coatings base on argent nanoparticles to be applied on titanium substrates, IVACE 19-20
- SOLGELMADERA – Multifunctional and hybrid coating for wooden elements to be used in interior ambient, IVACE 18-19
- RECORD – Development of new generation anticorrosive high behaviour coating, RTC-2015-3513-5, Ministerio de Ciencia, Innovación y Universidades, 2015-2019
- Research on resins formulated with additives and fillers with high fire behaviour to be used on wooden elements to fulfil Euroclass A2, CDTI 2016 – 2018 (Company’s project).

List of papers:

- Rosa Pérez, Julián Moratalla, Veneer coloration and matching using ultraviolet radiation. DREWNO - WOOD JOURNAL 2007 no 178
- Grassi, A.P. ; Perez, M.A.A. ; Leon, F.P. ; Campos, R.M.P., Detection of Circular Defects on Varnished or Painted Surfaces by Image Fusion, Multisensor Fusion and Integration for Intelligent Systems, 2006 IEEE International Conference, pages 255 – 260, E-ISBN : 1-4244-0567-X, Print ISBN: 1-4244-0566-1
- Microencapsulation of cerium and its application in sol-gel coatings for the corrosion protection of aluminum alloy AA2024, A. Valero-Gómez, J. Molina, S. Pradas, M.J. López-Tendero, F. Bosch, 10.1007/s10971-019-05151-8.

List of patents:

- Artificial vision system to detect defects on coated surfaces, 2 381 723, 16-04-2013

iii List of research projects:

- RESTRUCTMAD – Research and development of innovative solutions for retrofitting wooden structures, IVACE 20-21
- MEND-ME – Development of methodology for non destructive testing applied on structural Wood to be use don restoration, IVACE 19-20
- Celluwood, Laminated Strong Eco-Material for Building Construction Made of Cellulose-Strengthened, UE 2011 – 2013

- NANOMAD. Nano-technologic treatment for wooden elements to improve fire behavior, MICINN 2009-2011.
- MATRAFOC – Improvement of fire behaviour of treated wood for different end uses, IVACE 2019
- Development of new sustainable for inside and outside ambient in construction (RPETSTONE), CDTI 2017 – 2019 (Company's project)

List of papers:

- Manuel Rebollar, Rosa Pérez, Rosario Vidal, Comparison between oriented strand boards and other wood based panels for the manufacture of furniture. Materials and design, 2006
- CELLUWOOD PROJECT: Laminated strong eco-material for building construction made of cellulose-strengthened woods, Miguel Ángel Abián, Guillem Segura, Patricia Boquera, 978-84-697-2060-8
- Analysis of influence of materials used in interior ambient on fire unleashing, Stephane García, Raquel Cánovas, Nerea Carpintero, Rosa Pérez, 978-84-617-6380-1
- Evaluation of thermally-treated wood of beech (*Fagus sylvatica* L.) and ash (*Fraxinus excelsior* L.) against Mediterranean termites (*Reticulitermes* spp.), Oliver-Villanueva, J.V., Gascón-Garrido, P. & Ibiza-Palacios, M.S. Eur. J. Wood Prod. (2013) 71: 391, ISSN 0018-3768
- Resistance of wood modified with different technologies against Mediterranean termites (*Reticulitermes* spp.), P. Gascón-Garrido, J.V. Oliver-Villanueva, M.S. Ibiza-Palacios, H. Militz, C. Mai, S. Adamopoulos, ISSN 0964-8305
- Treatment of natural wood veneers with nano-oxides to improve their fire behavior, A B Francés Bueno, M V Navarro Bañón, L Martínez de Morentín and J Moratalla García, doi:10.1088/1757-899X/64/1/012021

^{iv} List of research projects:

- Research and development of new sustainable solutions to holistic management of CDW (construction demolition waste) . Development of mortar from recycled aggregates , AVI 2020-2021 (Company's project)

List of papers:

- Ceramic material reinforced with metallic fibers, SABURIT LLAUDIS, A.; VICENT CABEDO, M.; GARCÍA TEN, F.J.; NIÑEROLA GONZÁLEZ, RUBÉN.; MARTÍNEZ DÍAZ, ELKIN, 978-84-959-3126-9

^v List of research projects:

- Habitat Sostenible – Development and integration of solutions to improve the ambient comfort, IVACE 2013-2015. TP: Soluciones para el confort ambiental.
- SH BUILDINGS - Smart Heritage Buildings, SOE3/P1/E508, 2012 – 2014, INTERREG IV SUDOE
- SHCITY-SMART HERITAGE CITY

List of papers:

- Miguel Ángel Abián, Rosa Perez y otros, European project SHCity: Sustainable management and preserving of historic urban sites by technologies from Intelligent Cities, Gestión Municipal 2018
- Miguel Ángel Abián, Rosa Perez y otros, Smart Heritage Management - The SHCity Project Approach, 2018 International Conference on Intelligent Systems (IS)
- Advanced wireless sensors for termite detection in wood constructions, J. V. Oliver-Villanueva & M. A. Abián-Pérez, ISSN 0043-7719 Volume 47 Number 2 Wood Sci Technol (2013) 47:269-280
- Smart Heritage City: A Project for a heritage intelligent city, Rosa Ruiz Entrecañales, Aurélien Henon, Fernando Monteiro, Susana San José Alonso, Alessandra Gandini, Mikel Zubiaga, Rosa Pérez, Miguel Ángel Abián, Jose Carlos García García, Daniel Basulto García-Risco, 978-1980878469
- SMART HERITAGE CITY, Daniel Basulto, Jose Carlos García, Rosa Ruiz, Aurélien Henon, Adriana Mar, Fernando Monteiro, Susana San José, Alessandra Gandini, Mikel Zubiaga, Rosa Pérez, Miguel Ángel Abián, 2386-8198/978-84-697-7033-7

- Smart City Trends. Trends on Intelligent cities and opportunities for hábitat sectors, M^aGiuseppa Casado D'Amato, Cristina Revert Carreres, Vicente Sales Vivó, Sabrina Veral Borja, 978-84-941029-3-6
- Analysis of CO₂ as bio-indicator of termite degradation in wood structures, JV Oliver-Villanueva, MS Ibiza-Palacios, V Lerma-Arce, JE Luzuriaga, ISSN: 1336-4561

List of patents:

- Apparatus and methodology for detecting bio-degradation in wooden elements, 2 324 445, 22-04-2010
- Automatic tool and methodology for detecting and quantification of termites from emitted CO₂, 2 369 294, 16-10-2012
- Automatic tool and methodology for detecting and quantification of termites from emitted CH₄, 2 368 392, 03-10-2012

^{vi} List of research projects:

- Development of new construction systems made of wood veneer and glass laminate for light structures to be used as coverings, IVACE 10-11
- PRESOST-Development of pre-fabricated elements for inside and outside construction, Consellería de Innovación, Universidades, Ciencia y sociedad Digital, GV 2021

List of papers:

- Design and construction of light structures made of wood veneer and glass laminate, Miguel Ángel Abián, Manuel García y Kiyanshid Hedjri, 978-84-95077-53-0

List of patents:

- Method for manufacturing glass laminate with modified wooden veneer and its use in construction, ES2538041, 16/12/2013

^{vii} List of research projects:

- Development of the complete workflow for producing and using a novel nano-modified Ti based alloy for additive manufacturing in special applications: Nanotun3D.
- Processing of alloys prone to hot cracking using additive laser beam manufacturing technologies. HOTC
- Feasibility study and conceptual development of an additive manufacturing technology for the furniture and wood sector. FAMA.
- Advanced machining system for complex parts manufactured using additive manufacturing technologies (3D Printing). PRECISION FA.
- Definition of a design methodology for the customization of products adapted to the morphological variability of the population, manufactured using Flexible production technologies. CUSTOM ON BODY.
- Improvement of the performance of materials processed with additive manufacturing through post-processing. SKIN.
- Evolution of the thermal process in additive manufacturing technology in metals. SUPPORT-ZERO.
- Development of ultralight alloys to be processed with additive manufacturing technologies. ULTRALIGHT.
- CUSTODIAN: Customized photonic devices for defectless laser based manufacturing
- INEX-ADAM: INCREASING EXCELLENCE ON ADVANCED ADDITIVE MANUFACTURING