
INNOVATION WITH PURPOSE
AIMPLAS

BIO4EEB

Bio insulation materials for enhancing the energy performance of buildings

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Introduction to BIO4EEB project

Introduction to biomaterials

Biomaterials are those that:

- Come directly from nature and are biodegradable.
- With a reduced or zero carbon footprint.
- Ideally locally sourced.
- In many cases renewable.
- Harmless to human health.

Introduction to biomaterials

Their use has numerous socio-economic and environmental benefits, since supports local and nearby production, and optimizes the use of waste.

Materials with a reduced ecological footprint, which have been in the construction sector for several thousand years (wood, earth blocks, fiber-based insulation…), and which had been left behind due to the rise of industrialized materials, are positioning themselves again in the market accompanied by investment in innovation, emerging companies and technologies that facilitate their use on a large scale.

Examples of biomaterials

Wood

Cork

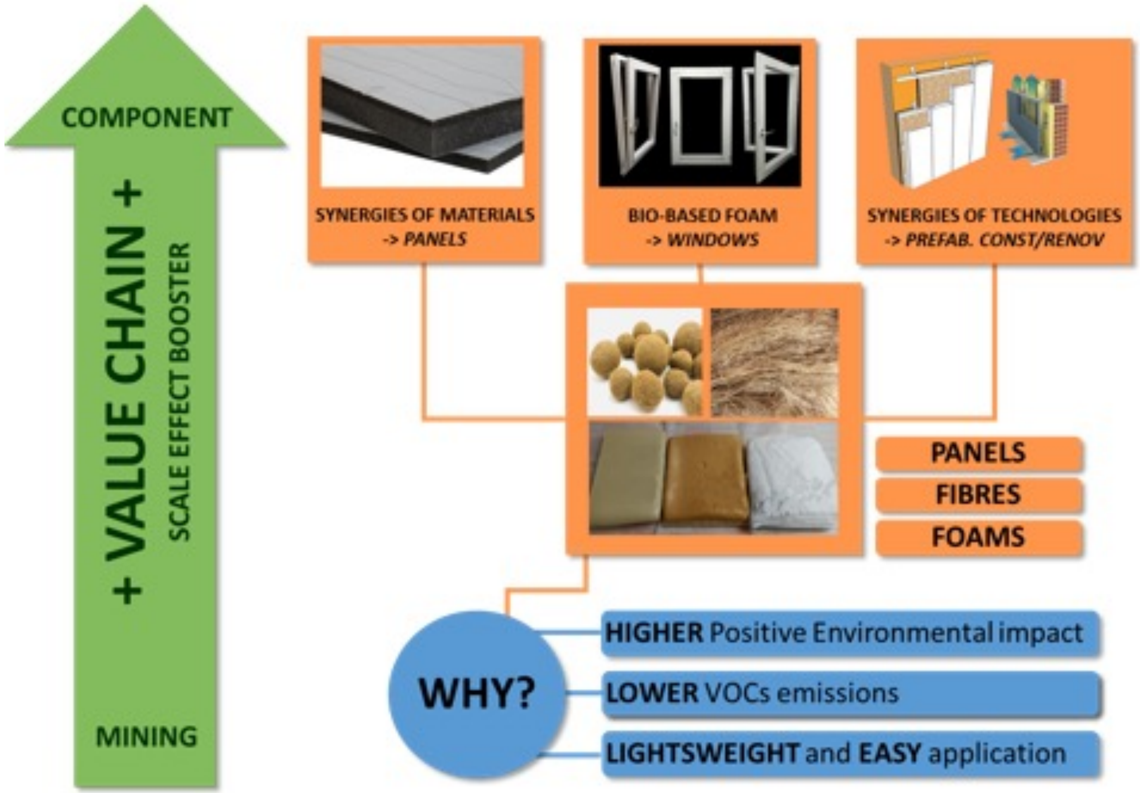
Ground

Bamboo

Natural stone

Fungal mycelium

Materials developed within the project



WHY BIO-sourced Materials?
and
WHY Bio-based building components?

Portfolio of bio-based insulation solutions in the form **of Posidonia and fibers, complex polyelectrolytes, PLA and bio-polyurethane foams,**

→Panels, bio-based windows and finally a pre-fabricated façade elements which aggregates these different materials

Complementarity → Strong point for the project.

BIO4EEB does not focus on a narrow solution, but on a wide spectrum of solutions, adapted to various situations

Materials developed within the project

The BIO4EEB project aims to develop a portfolio of bio-based thermal insulation solutions in the form of Posidonia panels and PLA foams, both modified with additives to improve their fire-resistant properties, and windows made with bio-polyurethane foam.

It is an ambitious project because, compared to current materials, the developed materials should offer:

- At least a 30% reduction in energy and CO_2 at the component level;
- At least a 20% improvement in insulation properties;
- At least a 15% reduction in total costs compared to existing solutions;
- At least a 5% reduction in energy expenditure over the entire lifecycle of a building.
- Greater lifespan, lower maintenance costs, and a lower environmental footprint.

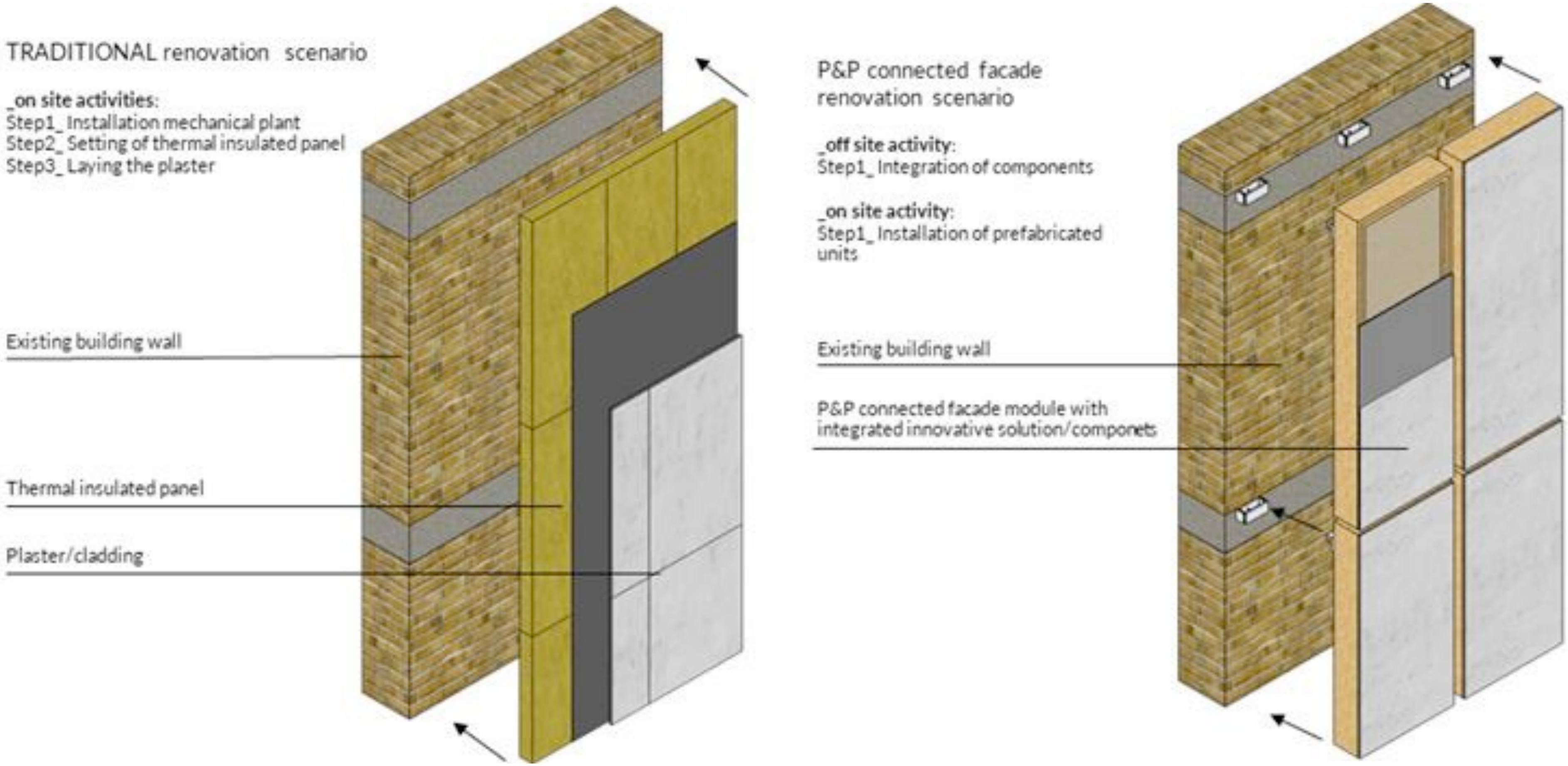
Materials developed within the project

The complementarity between the solutions to be developed in BIO4EEB is a strong point of the project, which focuses on several solutions, adapted to different situations.

Finally, the different solutions will be integrated into a prefabricated façade element that combines these different materials according to the needs of each building.

To demonstrate this, five real-life demonstration cases have been selected, covering different building typologies and environments, and testing different solution configurations.

Materials developed within the project



PEC coatings

The focus of this task has been the synthesis of polyelectrolyte complexes (PECs) based on chitosan and phytic acid, specifically tailored for application as bio-based flame retardants in coatings for construction-related applications.

The aim was to develop a sustainable, bio-based flame-retardant additive suitable for incorporation into coatings used in the construction industry, achieved through mechanochemical synthesis.

Once the PEC was characterized it was used as a filler in a coating. The PEC was dispersed in an unsaturated polyester resin, with the aim of obtaining a stable dispersion over time that allows application on desired surfaces.

PEC coatings

Synthesis of PEC by mechanochemistry

PEC coatings

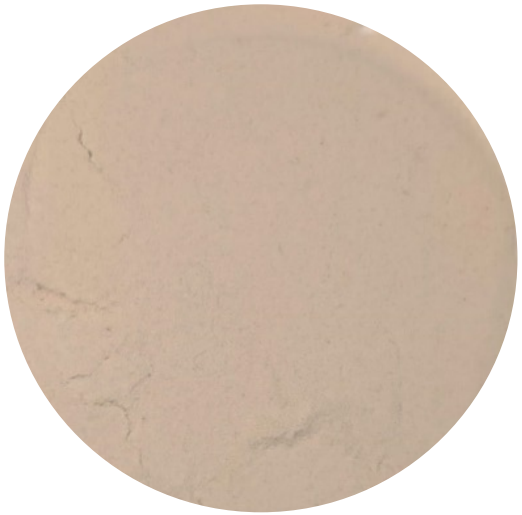
Screw design was tailored to modify mixing intensity and residence time.

Different configurations of screw elements were tested to achieve efficient mixing without causing excessive shear, which could degrade the reactants.

Production rate and screw speed were adjusted in tandem to fine-tune residence time and shear forces within the extruder.

To further enhance the properties of the PECs, physical post-treatment focused on reducing the particle size to a range of 10-15 µm using a cryogenic miller, which is crucial for maximizing dispersion within coatings and enhancing flame retardant performance.

PEC coatings



Cryogenic miller and particle size before and after.

PEC coatings

Different percentages of PEC were dispersed in the resin.

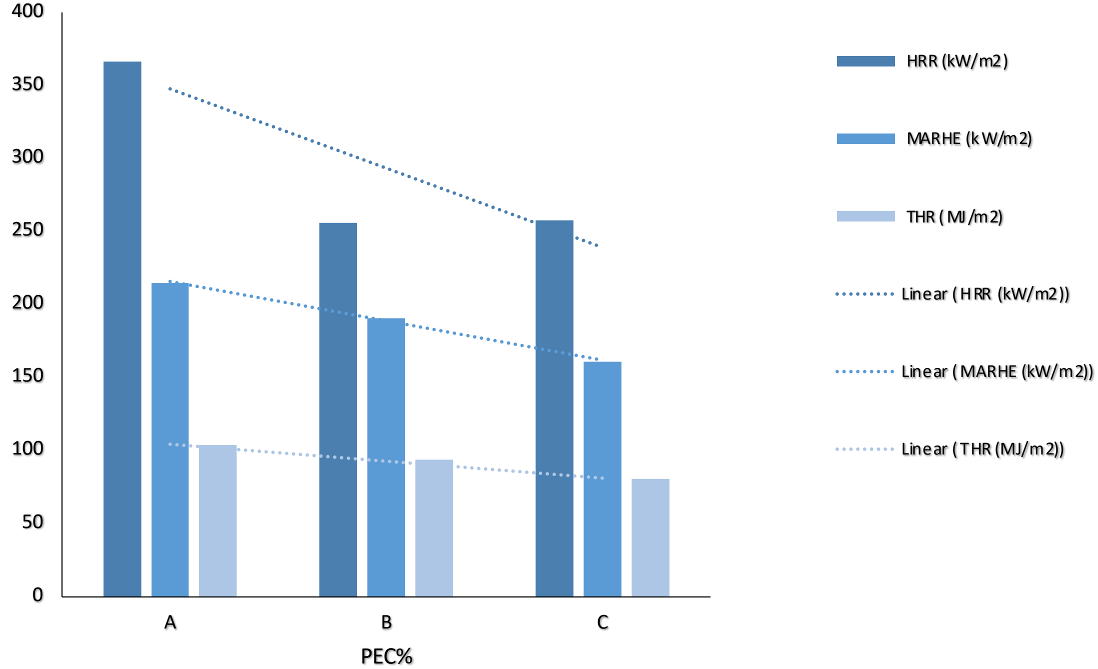
The optimal percentage of PEC in relation to its performance was determined through characterization.

PEC coatings

Curing was carried out and the formulations were applied as a coating using a brush on a Posidonia panel sample.

PEC coatings

The values of HRR (intensity of the fire), THR (total heat released) and MARHE (maximum value of the average heat emission rate), show a decrease in heat release as the percentage of PEC in the resin is increased and, therefore, a better fire performance.

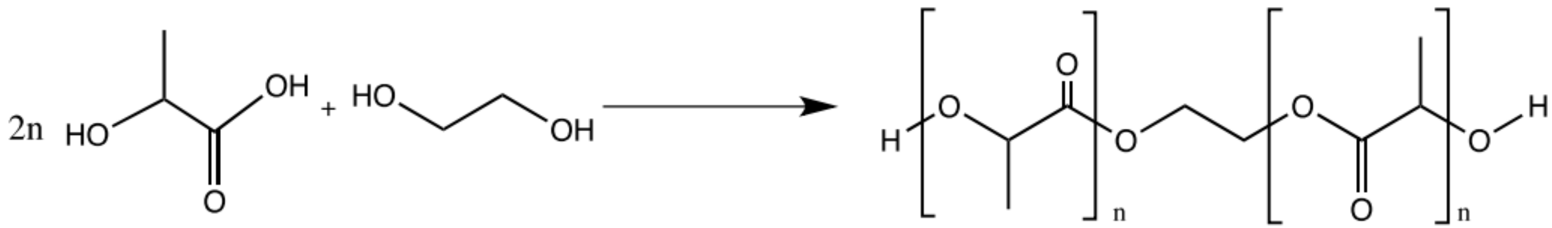


Sample	%PEC	HRR (kW/m^2)	THR (MJ/m^2)	MARHE (kW/m^2)
PRO22-0040-53-01-01	A	366,42	103,85	214,92
PRO22-0040-53-02-01	B	255,86	94,07	190,76
PRO22-0040-53-03-01	**C**	**257,92**	**80,67**	**161,13**

PLA foams

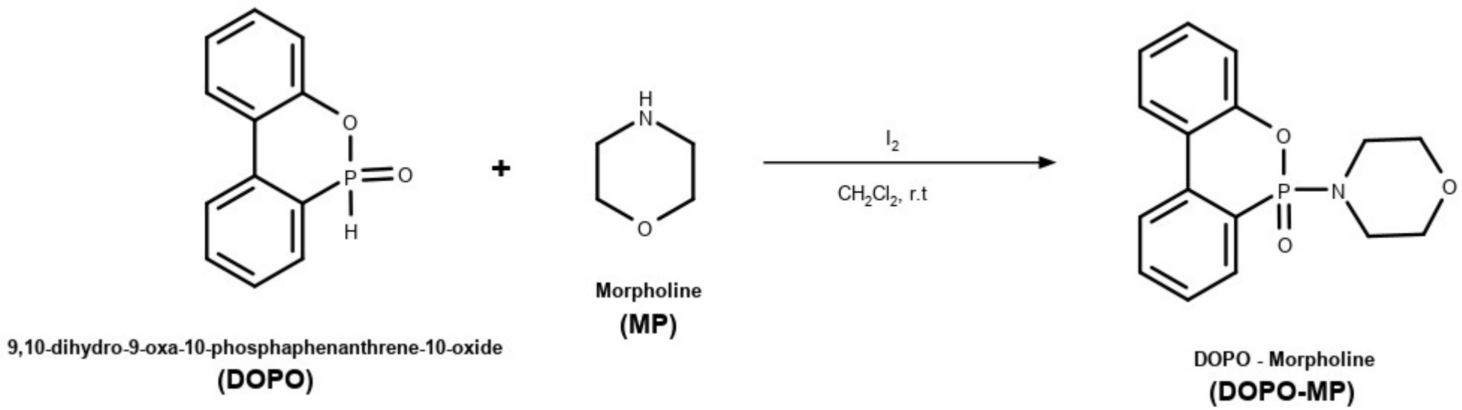
The aim of this task is the synthesis of a bio-based polyol derived from lactic acid, for application in the formulation of flexible polyurethane (PUR) foams. This way, the content of bio-based material in the PUR formulation can be considerably increased.

For this purpose, different routes of synthesis, raw materials and experimental conditions were investigated to achieve a polyol with optimal molecular weight, viscosity and hydroxyl number similar to fossil-based commercial ones.



PLA foams

On the other hand, a flame-retardant additive for PLA foams derived from DOPO (9,10-dihydro-9-oxa-10-phosphaphenanthrene-10-oxide), was developed through a sustainable process that eliminates the use of halogenated intermediates, designed and optimized using AIMPLAS's know-how and protected under patent WO2023/09452.

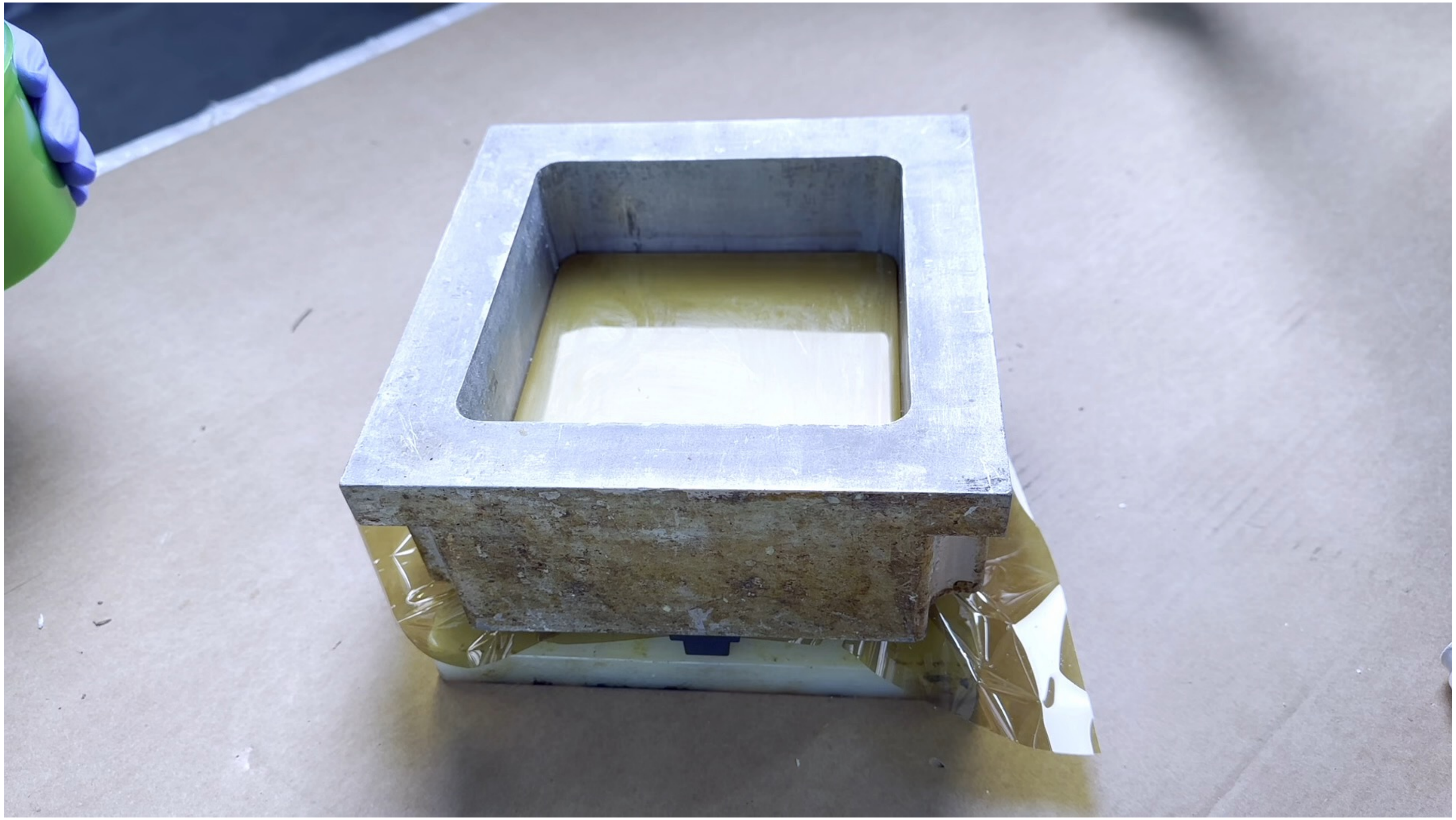


PLA foams

Finally, different rigid PLA-based polyurethane insulating foams were synthesized in which the percentage of flame-retardant additive was modified.

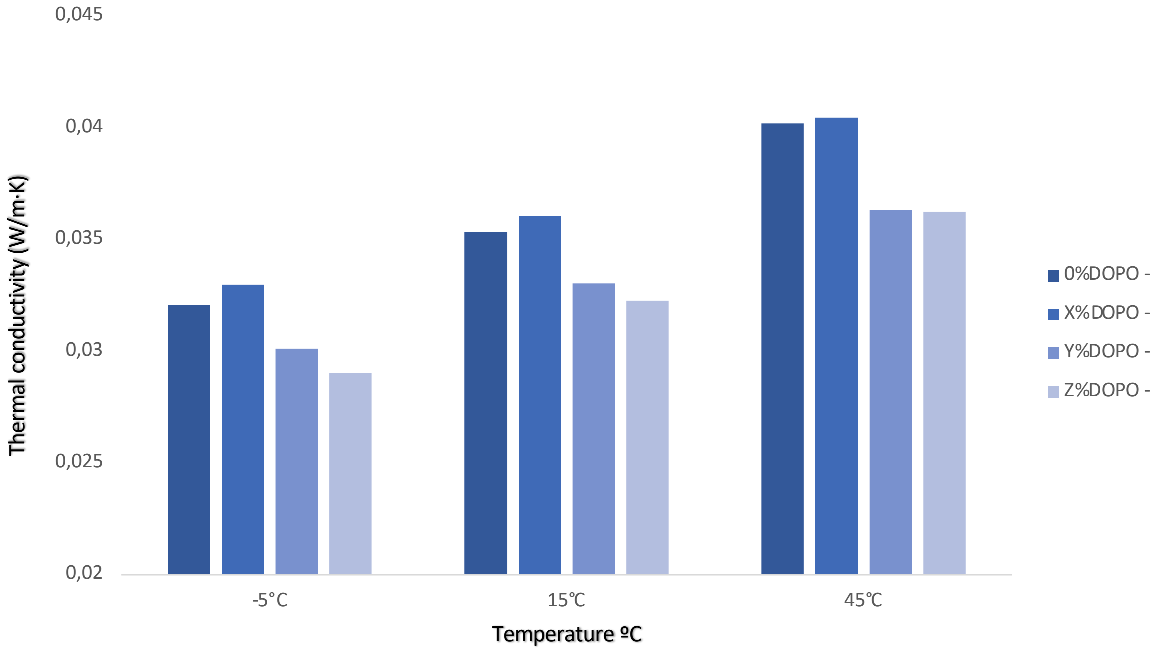
Foams were obtained to study the thermal conductivity and fire behaviour depending on the DOPO load of each of the foams.

PLA foams



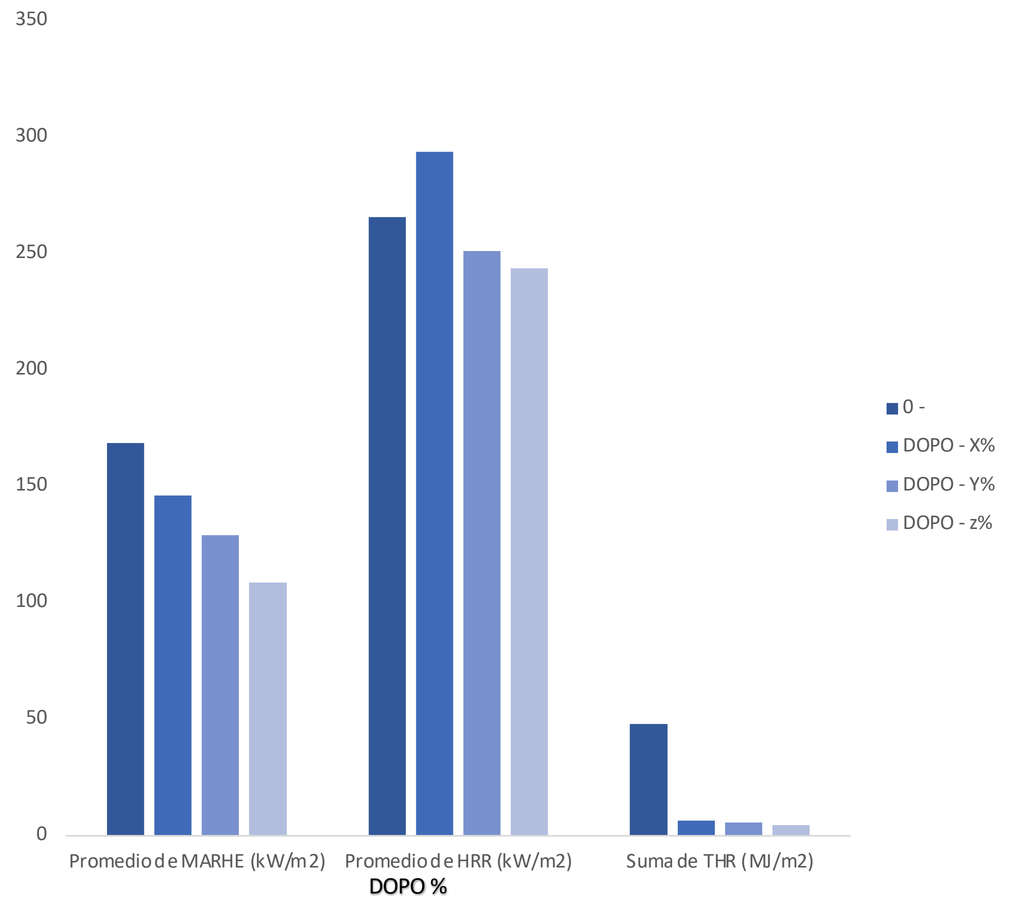
PLA foams

The values represented show a decrease in thermal conductivity when DOPO is added to the formulation.



PLA foams

The use of DOPO in the formulation decreases the values of THR, HRR and MARHE, compared to not using DOPO in the formulation.



Conclusions

Although fire behaviour improves with increasing PEC in the coating formulation, in no case is the insulation system formed by the coating and the Posidonia insulation panel fire resistant. Sample **PRO22-0040-53-03-01** was selected for the scale-up.

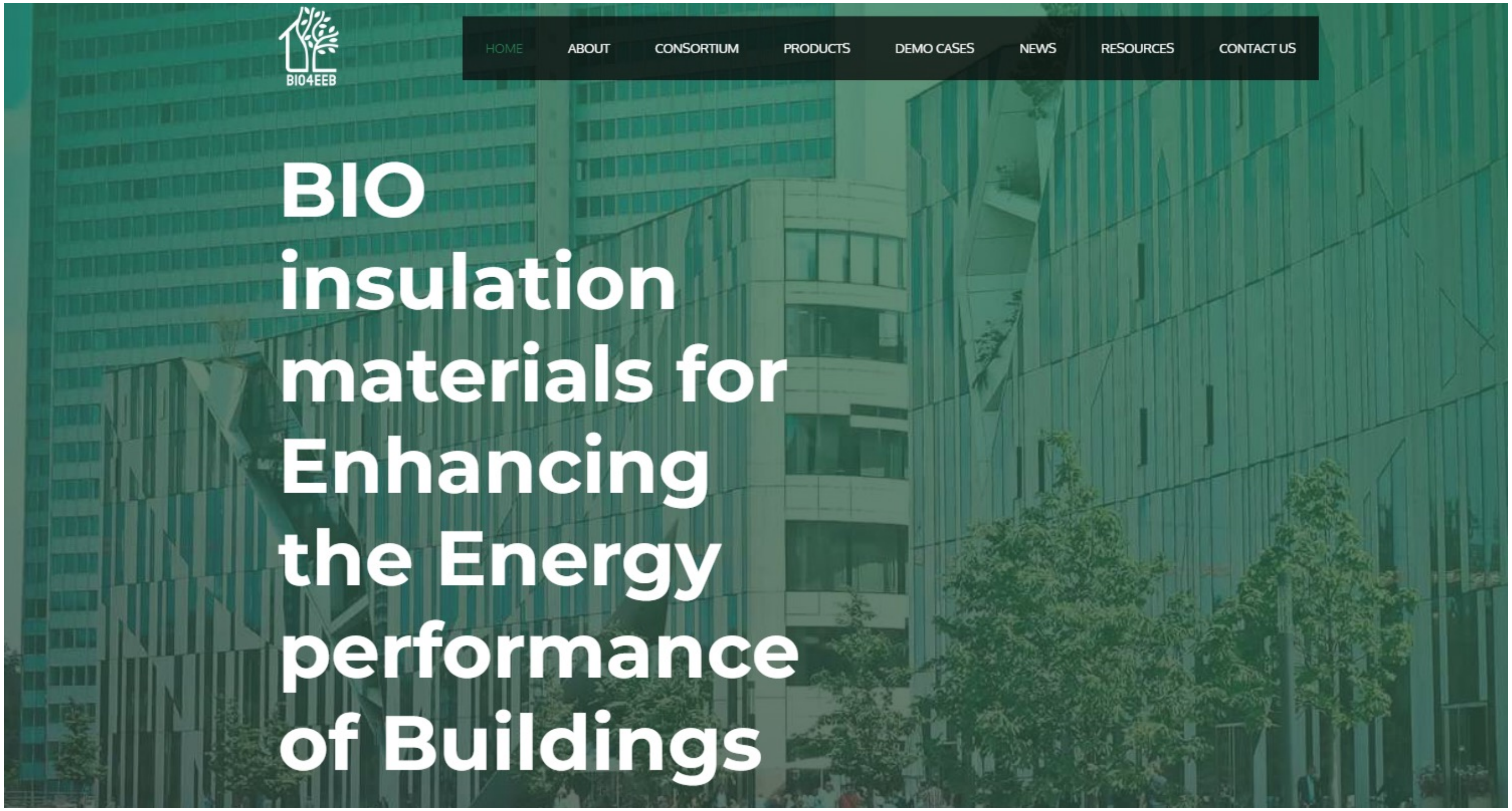
Considering the values of the tests carried out and their economic impact, **Y% DOPO** in the PUR foam formulation presents a substantial improvement both in the behaviour of the foams with respect to thermal conductivity and in the calorimetric cone tests.

Project social media

https://twitter.com/BIO4EEB

https://www.linkedin.com/company/bio4eeb/

https://www.bio4eeb.eu/



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