iCLIMABUILT

Functional and advanced insulating and energy harvesting and storage materials across climate adaptive building envelopes

Volume 3

Project Overview

iclimabuilt's goal is to create an open access ecosystem for developing, upscaling and testing innovations in building envelope materials and technical systems via its 9 Pilot Lines (PLs) to reach Nearly Zero Energy Buildings (nZEB) balance.

Through the iclimabuilt project a cross-domain business ecosystem combining the capabilities of different experts, building the connection between suppliers and users, based on the cooperation within interdisciplinary entities to support new product development/upscaling and testing, satisfy customer needs based on a case-by-case assessment of the underlying barriers of each technology, and eventually incorporate the next round of innovations in building envelope materials and technical systems will be formed.

27	14	10	48
Partners	Countries	Work Packages	Months

Project Overview

iclimabuilt will support the translation of research results into innovations and will help small high-tech firms to scale up and cope with the continuous rising of technological complexity by providing a **Single-Entry-Point** for necessary infrastructures and tools to test, validate and upscale new technological solutions.

iclimabuilt will do so with the aim to accelerate the development of additional leading-edge technology by focusing on:

- **Materials Development**
- **Design and Assembly of Technical Systems**
- **Monitoring and Characterization Strategies to Support Decision-Making**
- **Dissemination and Exploitation Activities**
- **Refined and Expedited Access to Financing Solutions**

An open innovation test bed for building envelope materials

Partners

National Technical University of Athens/R-NanoLab
Eurecat- Technology Centre of Catalonia
Technical University of Dresden
SINTEF
Norwegian University of Science and Technology
Research Institutes of Sweden
INEGI – Institute of Science and Innovation
Innovation in Research and Engineering Solutions
University of Strathclyde
Granta Design
Hamburg University of Technology
Stratagem Energy
Fraunhofer Institute for Solar Energy Systems
Polytechnic University of Turin
Technological Institute of Aragon
Cidetec
E2ARC Architecture Research for Cities
AiDEAS
TEGnology
Fenx
European Research Center for Design and Materials Technologies
Bergamo Tecnologie
Open Source Management
Rubitherm Technologies GmbH
University of Birmingham
BioG3D
Leipzig University of Applied Sciences

Performing risk and safety activities

IRES travelled to Germany to perform risk and safety activities in the iclimabuilt project framework. First visit was at Leipzig/Oschatz where an on-site exposure assessment was performed by the IRES specialized Risk and Safety team and equipment, on a production line demonstrating the upscaling of the TRC (textile reinforced concrete) for advanced building applications, developed by HTWK Leipzig. Particulate exposure levels were recorded across the various steps of TRC production: mixing, casting, demolding. The next destination was Hamburg, at the facilities of TUHH, where an on-site evaluation took place, regarding the safety aspects and emissions potential of the production stages and handling of aerogels, consisting of very promising materials under research in terms of thermal efficiency for buildings and other sectors.

IRES in Germany

First fully autonomous wireless humidity sensor

In the course of the iClimabuild project TEGnology developed the world's first fully autonomous in-situ wireless humidity sensor that is powered by thermal energy harvesting from the temperature difference between the outside and inside air of a building.

The projects investigated different sensor methods and found a standard humidity air sensor to be feasible for being implemented in the novel cellular lightweight concrete (CLC) insulation material developed by RISE.

The current device has been tested inside a produced wall segment (see pictures) and could provide LoRa transmitted measurement data transmitted in intervals of 20min at an inside/outside temperature difference of only 5°C. The device can work at reversable conditions and thus delivers measurement data when the inside air is colder than the outside air and also when the inside temperature is higher than the outside temperature.

First fully autonomous wireless humidity sensor

The developed electronics will be used in new monitoring devices that have to be functional at very low deltaTs, like for example monitoring sensor mounted to buildings, containers or server room doors. The very low required temperature difference will increase the application range of thermal energy harvesting significantly and it is expected that this technology will play a decisive role in digitizing the industry with maintenance free and thus cost efficient solutions

The sensor system has now been implemented in a final wall segment that will be mounted to the Living Lab CUBE. Here it will be tested for at least 12 months.

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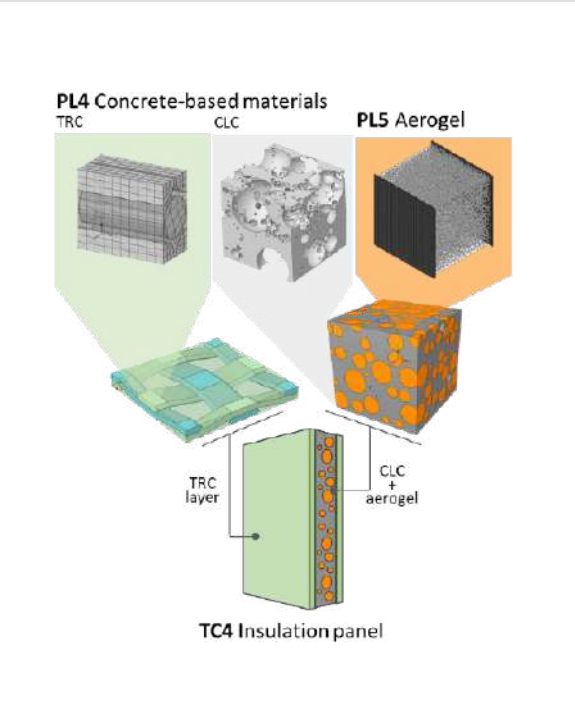
The development and test is a joined development between TEGNology and RISE and we would like to thank Jan Suchorzewski (RISE) and Dusan Vuckovic (TEGnology), who developed, implemented and tested the technology required for this novel sensor system. The results of the development and tests will be presented as a paper at Nordic Symposium on Building Physics in Aalborg, Denmark on 12-14 June 2023.

Cooperation

ITAINOVA, TUHH, HWTK Leipzig, RISE, Polito, TU Dresden

Simulation support for combining Concrete-based materials (PL4) and aerogels (PL5)

As part of the iClimaBuilt project, it is developing the design of insulation panels (Test case 4) through the combination of aerogels (PL5) and concrete-based materials (PL4) such as Cellular Lightweight Concrete (CLC) and Textile-Reinforced Concrete (TRC). Nevertheless, the configuration of this combination requires numerous experimental tests, which could be partially avoided by simulation-based design tools. The Technological Institute of Aragon (ITAINNOVA), in collaboration with TUHH, HWTK Leipzig, Polito, RISE and TU Dresden, is developing a multi-scale methodology to evaluate virtually the thermal behaviour of these panels. To this end, the following actions have been performed:



- Numerical approximation of the microstructure of the aerogel in a Representative Elemental Volume (REV) for testing its thermal properties.
- Generation of REV of CLC material with and without aerogel particles to evaluate the final properties of the mixture.
- A multi-scale approach for mimicking the TRC response.

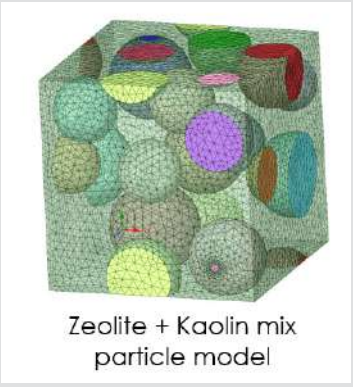
Cooperation

BIOG3D, IRES, NTUA, ITA

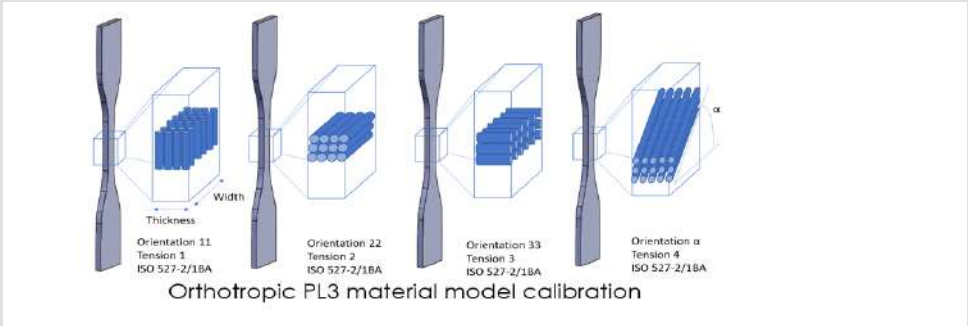
iClimabuilt PL3 simulation support. Material models.

Development of Test Case 7 (TC7) for 3D printed customizable components includes detailed simulations of a hook/mounting arrangement manufactured with PLA thermoplastic based on a FFF manufacturing process. Furthermore, the modelling of the joining systems of an air quality absorber based on mineral powder pastes and the evaluation of the load-bearing capacity. For this purpose, it was identified the need of developing specific material models for the two case studies, accounting for the following actions.

- Testing campaign on PLA and Kaolin Zeolite materials
- Material model calibration and parametric metamaterial



Zeolite + Kaolin mix particle model



Orthotropic PL3 material model calibration

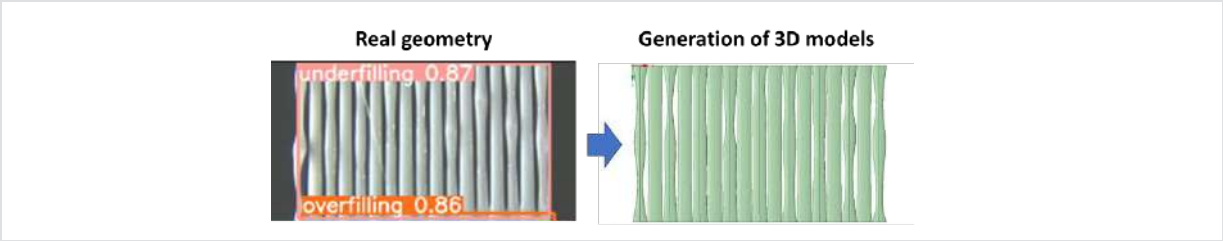
Cooperation

BIOG3D, IRES, ITA

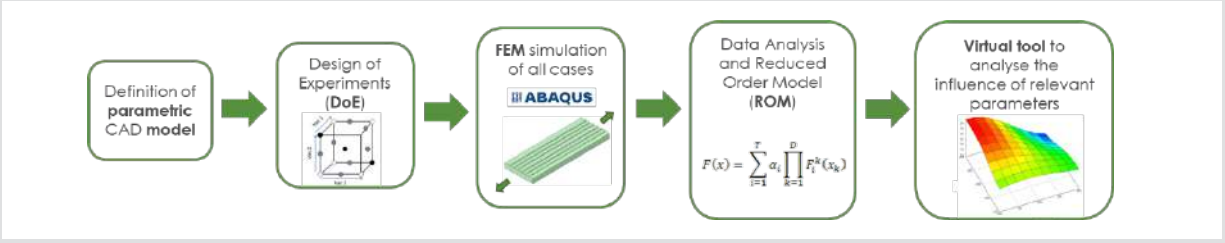
iClimabuilt PL3 simulation support. Impact evaluation of printing defects on micromechanical properties

The main scope of the in-line monitoring system included on Pilot Line 3 is to automate the detection of Defects at 3d-printed thermoplastics of Fused Filament Fabrication (FFF). The defects have been classified into three categories: 1) overfill, 2) underfill and 3) impurities. In order to complement this activity, ITAINNOVA has proposed to generate micromechanical models to study the influence of these defects on the mechanical response of printed filaments by means of FE simulations. For this task, two phases have been defined:

Phase I, Direct analysis:
3D models reproducing the geometry of the defects are defined for a selection of representative cases.



Phase II, Predictive analysis:
Building on a parametric model, the influence of relevant parameters on the filament single-layer response could be addressed. The Reduced Order Modelling (ROM) technique would be used.



20M progress meeting

The iCLIMABUILT first F2F meeting is hosted by partner INEGI from the 28th to the 30th of November in Porto (Portugal).

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