PhD Program in Civil, Chemical and Environmental Engineering
Curriculum in Structural and Geotechnical Engineering, Mechanics and Materials

Industrial Projects

June 2024 Call, XL cycle - Starting date: November 1 st 2024

The research projects submitted for the admission to the PhD program must be prepared in accordance to one of the projects listed below. Click on the Title to go to the Project.

Ph.D. Program in Civil, Chemical and Environmental Engineering
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Università di Genova | **DICCA** Ph.D. PROGRAM IN CIVIL, CHEMICAL AND ENVIRONMENTAL ENGINEERING

***Thematic*: Mechanics of materials and structures**

Project: Optimization of hierarchical sandwich structures (with ThermHex Waben GmbH)

Keywords: green sandwich composites, material/structure optimization

Brief Description:
Sandwich structures, with facesheets made of fiber-reinforced plastics and light plastic-based foam or honeycomb cores, have very high weight-specific strength and stiffness, which make them suitable for the design of resilient structures in aircrafts, vehicles, ships and wind power blades. These products are typically made with complex manufacturing processes and have high production costs. The new organosandwich technology aims at producing fully thermoplastic cost-effective and fully recyclable (green) sandwich structures. Thermoplastic honeycomb cores may be manufactured with a continuous production process (TermHex patent). However, thermoplastic cores show lower weight-specific properties, mainly due to the lower buckling strength of the cells. To overcome these issues ThermHex Waben GmbH has been recently worked on the design of thermoplastic sandwich structures with a hierarchical structure, where honeycomb cells and skins are themselves flat honeycomb sandwiches. Preliminary studies show the potentials of this material architecture but also highlight the need for additional work to optimize the geometrical properties of core and skins to improve overall performances.

The PhD student will work at UniGe and ThermHex Waben GmbH, Halle (Saale) Germany, and join ongoing collaborations with colleagues at DTU (Denmark) and the Fraunhofer Institute for Microstructure of Materials and Systems, Germany. Aim of the project is the optimization, accounting for all local and global failure mechanisms, of the geometric design parameters of the new type of hierarchically structured sandwich materials to improve weight specific properties.

Referent: Roberta Massabò (roberta.massabo@unige.it) (UniGe), Jochen Pflug (ThermHex Waben GmbH)

Relevant links: https://thermhex.com/
https://rubrica.unige.it/personale/VUZEUl1v

Figure: hierarchical sandwich structures and failure modes

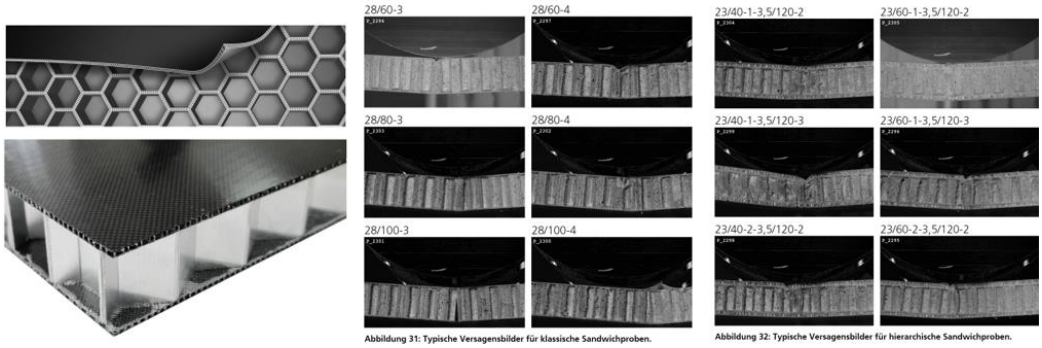

Abbildung 31: Typische Versagensbilder für klassische Sandwichproben.
Abbildung 32: Typische Versagensbilder für hierarchische Sandwichproben.

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***Thematic*: Mechanics of Materials**

Project: Exploration of different bio-encapsulation approaches for the inclusion of PCM in construction and building materials (with Sphera Encapsulation)

Keywords: Building materials, Thermal energy storage (TES), Phase change materials (PCM), Organic PCM, Microencapsulation, Thermal conductivity, Sustainable encapsulation, Greenhouse emissions

Brief Description:

The consumption of energy is constantly growing. Just in Europe, 40% of the total energy consumption is dedicated to building, which is guilty of producing 36% of the total greenhouse emission in Europe. The use of phase change materials (PCM) is increasing as one of the most preferred forms of thermal energy storage (TES) system. This because, when PCMs are subjected to a particular temperature, they change phase from solid to liquid, and during this reaction, they absorb heat from the surrounding. When the temperature decreases, they return in their solid form, liberating passively the accumulated energy in the form of heat. PCM are the most effective way of energy storage since they show high energy storage density, good isothermal operating characteristics. Among them, organic PCM (e.g. paraffin and fatty acids/esters) showed to be more chemically stable, not corrosive, recyclable, and with no supercooling effect, but from another side, the extremely poor thermal conductivity has strongly restricted their application.

The main challenge to overcome this, and to take advantage of these materials is to find a way to integrate this type of system in buildings and increase their efficacy and thermal conductivity. In this context, microencapsulation of PCMs is a crucial step to allow the compartmentation of selected materials that can be included in building materials (e.g., bricks and concrete). Today is still not clear what is the best approach to encapsulate PCM, from one side there is the necessity to store a high amount of energy, having from the other side a very resistant capsules towards high pressure and extreme pH (e.g., 12). For the moment this is ensured by capsules that are based on plastic resins (e.g., polyurea) that are characterized by low sustainability but very high performances. This project will focus on the evaluation of new encapsulation approaches for PCM, focusing on the selection of natural materials (e.g., lignin, cellulose, and inorganic compounds) for the creation of a more sustainable shell. The project will evaluate the creation of micro and nanoparticles with high energy storage capacity and high resistance, evaluating their compatibility for the incorporation in construction materials such as bricks and concrete. Moreover, the inclusion of organic compounds will be investigated to increase the thermal conductivity of the developed MPCM.

Referent: Prof. Antonio Caggiano (antonio.caggiano@unige.it), Scopus-id=54916174800
Industrial Referent: Dr. Francesca Zanoni, PhD in Biotechnology (zanoni@spheraencapsulation.com)

PhD - DM630: Industrial co-funding Sphera Encapsulation S.r.l. (https://www.spheraencapsulation.com)

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