



# Technologies and Sustainable Solutions for the transition to Circular Economy

# A VISION FOR RESPONSIBLE DEVELOPMENT

Any raw material transformation should be approached with a clear sustainable solution to reclaim the same raw material at End of Life

GS4C is an Italian Innovative PMI specialising in Composite Materials Research and Development, fostering the transition toward responsible manufacturing



# **Cradle to Cradle Recyclable Composites**

Sustainable fibers and resins to obtain **full Cradle to Cradle recyclability for composites**. An industrial vision of full reclaim of raw materials at End of Life (including production waste) to be re-transformed into the original fiber and resin.

**No downgrade on products from recycled raw material**





# Leading the way in Recyclable Composites

Launched in 2020, Amável is a Mini650 demonstrating zero landfill boatbuilding, including a clear and sustainable end of life composite recycling with full Cradle to Cradle reclaim of reinforcement (validated in Enea) and recyclable sails.



Regione  
Lombardia



POLITECNICO  
MILANO 1863



ISOMATEX S.p.A.  
Advanced Fiber Manufacturer



CONFINDUSTRIA  
NAUTICA  
Italian Marine Industry Association



ASSOLOMBARDA  
Confindustria Milano Monza e Brianza





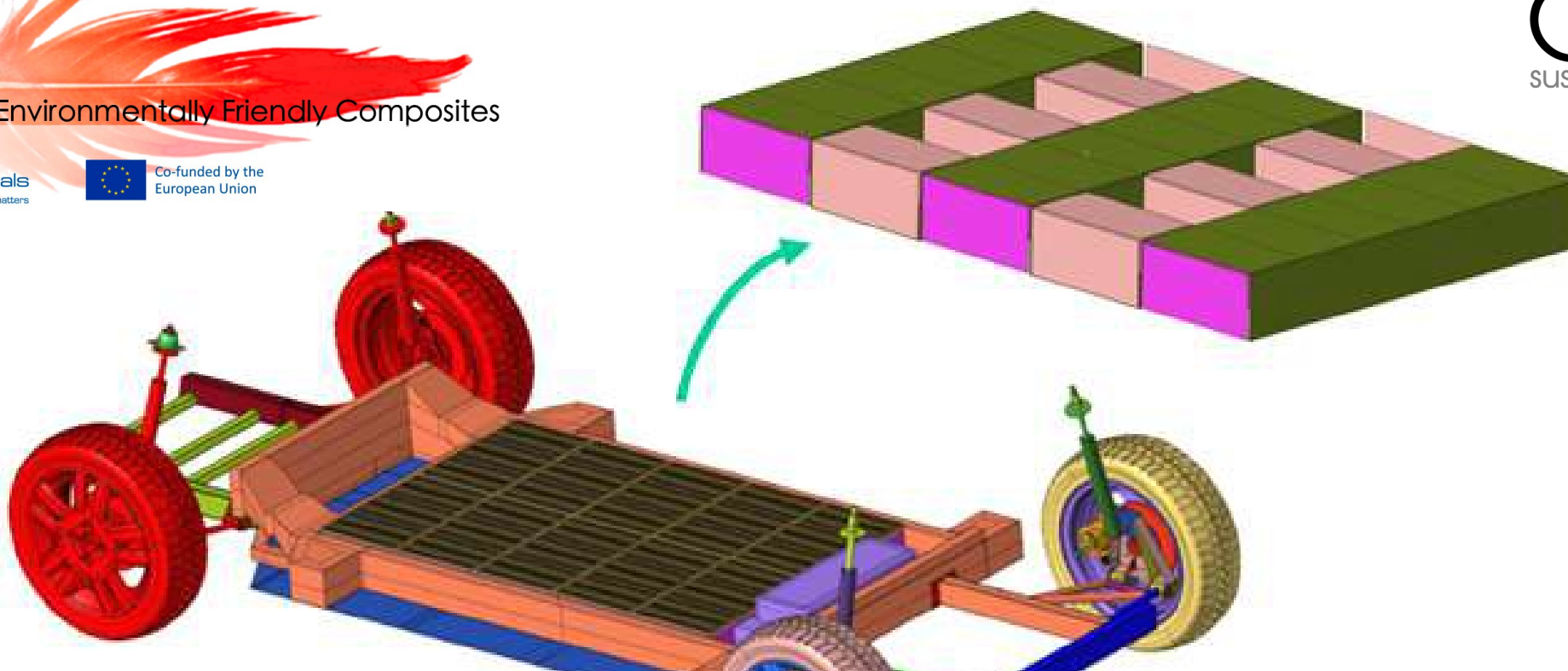
# Recyclable Composites for automotive

C2CC partners produced a Fiat500 Abarth bonnet using basalt fiber and recyclable bio-epoxy, validating the composite solution adopted for the construction of the Mini650 for automotive manufacturing. A new pre-preg was developed for the task.

# FENICE

Fire Resistant Environmentally Friendly Composites

Supported by

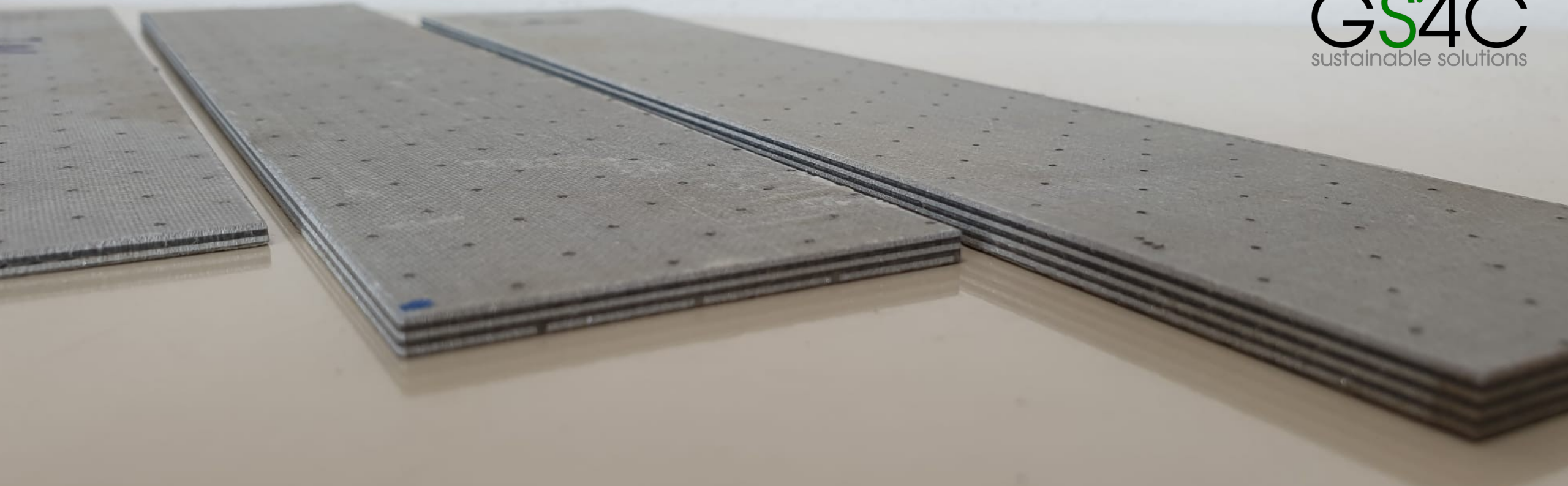


## Fire-Resistant Recyclable Composites

FENICE (Fire Resistant Environmentally Friendly Composites) aims at demonstrating that commercially available raw materials can be combined into innovative prepregs, unlocking a disruptive evolution in the automotive sector







# Sustainable Fiber Metal Laminates

B.Al.i (Basalt Aluminium infusion): Patented technology for out of autoclave Fiber Metal Laminate forming. The research is now focussing on thermoplastic resin as part of a funded Research with the Aerospace Department of Milan Polytechnic.



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DIPARTIMENTO DI  
SCIENZE E TECNOLOGIE  
AEROSPAZIALI



## Photonics for International Markets and Applications for Sustainability



## Innovative Hybrid Composites

SWIFT (Sustainable Weight reduction via Innovative use of Fiber Metal Laminate Technology) validated thermoplastic FML technology for automotive in collaboration with Jakar, maker of Ísar high-performance Ultra High Mobility (UHM) vehicles.



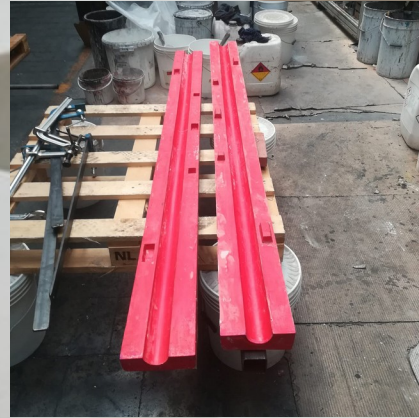
Co-funded by  
the European Union





# Artificial Fiber from Reclaimed Waste

SPARROW investigated the conversion of reclaimed slag from steelworks into fiber for composite reinforcement, upscaling the actual process of transformation of slag into artificial basalt to be used as conglomerate for the construction industry.



Glebanite moulds for Biotherm, class IMOCA

## Cradle to Cradle recyclable moulds

The “glemould” project validated moulds and tools made of “glebanite”, a material obtained from the recycling of fiberglass reclaimed at the end of its life. These moulds can be recycled into new glebanite at EoL



# The choice of Basalt Fiber

- High corrosion and fire resistance
- High tensile modulus, tensile strength and interlaminar shear strength
- High impact-resistance
- Low water absorption and is electrically non-conductive
- Sustainable and inherently C2C recyclable
- EU based raw material and manufacturing facilities
- Low environmental impact and low embodied energy\*

\* A full LCA of basalt fiber will be compiled as part of the FENICE project





# Ongoing Research – Basalt & Thermoplastic

The research in collaboration with the Composite Lab of the Aerospace Department of Milan Polytechnic will last three years, investigating Basalt and Thermoplastic composite sandwich structures for Marine applications:

- Lamination monitoring and modeling to optimise the infusion process
- Sandwich core optimisation and investigation of core-skin adhesion
- End of Life C2C raw material reclaim and production waste management





# Certification Process

Unidirectional Basalt fiber reinforcement has been certified for Marine Applications by RINA in 2022 after a thorough testing campaign carried at the ENEA laboratories.

Research is ongoing to fully qualify basalt reinforced composite for Super Yacht production.



# Ongoing Collaborations – Polimi Sailing Team

The Sailing Team of Politecnico di Milano, participating to the SuMoth Challenge since 2022

The PoliMi Sailing Team was born in 2007 to support the passion for sailing and the idea that **a more sustainable sailboat design is possible**. For the **SuMoth Challenge\*** 2023 the Team built a boat in **enriched basalt** with **recycled PET** core and **thermoplastic** resin. **Fiber optics** were inserted to monitor the composite's infusion and performances. Rigging is bio based and the sail is 100% recyclable.

*\*The SuMoth Challenge is a student competition where the teams ultimate objective is to design, manufacture and sail **the most sustainable and efficient foiling International Moth**.*







# Ongoing Collaborations – Polimi Physis PEB

The Team of Politecnico di Milano at the Monaco Energy Boat Challenge since 2022



Physis PEB developed a new lamination technique (**forged basalt**) with **chopped enriched basalt fibers** (~50 mm) from scraps of production and from recycled basalt fibers. The solution involves **bio-based and recyclable 3D printed thermoplastic molds**. The fiber's ratio of forged basalt is higher than traditional hand lay up lamination, increasing the mechanical properties of the workpiece, yet keeping the lightweight.



# Research Network and Partners

A network of talented people and companies sharing the vision for sustainable and responsible development

