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## APPLICATIONS

The main expected output of this research project is the development of new high-performance materials and the related manufacturing processes. The qualification and analysis of performances will be another fundamental step to meet the market's needs with new products and innovative technological solutions. A significant part of the research effort will be aimed at the implementation of pilot lines, in order to identify the possible bottle-necks to be solved in the scale up. The developed pilot lines will be aimed at studying:

- **Preceramic Prepreg** production (up to 1,3 m technical textile width)
- **Warm Pressing** thermoplastic forming (up to 1,3x2,5 m doors)
- **Pyrolysis** (up to 1,3x1,3 m panels)

Preceramic formulations suitable to apply the same technology with the **filament winding** technique (acquired in the previous project MITAI) will also be studied.

The reuse and exploitation of **ashes from biomass** and **composite wastes** (scrap materials, aged prepregs and "out of specification" or end-of-life components) are issues of strong interest for the regional entrepreneurial system, since the costs currently associated with the disposal of these wastes represent a heavy burden. Converting wastes into second raw materials can develop into industrial symbiosis of apparently completely different sectors, like food and construction industry. Polymer composites will be used to produce short carbon fibers by applying pyrolysis methodologies, whereas ashes, by their chemical and granulometric nature, are materials suitable for the production of geopolymers, both porous and compact.


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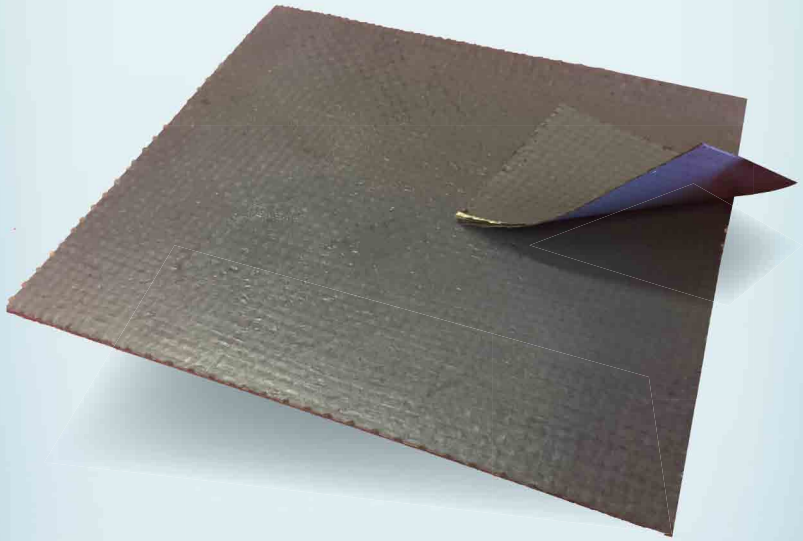
EEE CFCC

# ECONOMICALLY AND ENVIRONMENTALLY SUSTAINABLE EVOLUTION OF CERAMIC FIBER-REINFORCED COMPOSITES IN COMPLEX DESIGNS



**www.eee-cfcc.it**


Project co-funded by the Emilia-Romagna Region (Por-FESR 2014-2020)

POR FESR EMILIA-ROMAGNA 2014/2020
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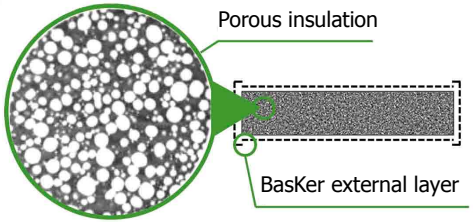
## THE PROJECT

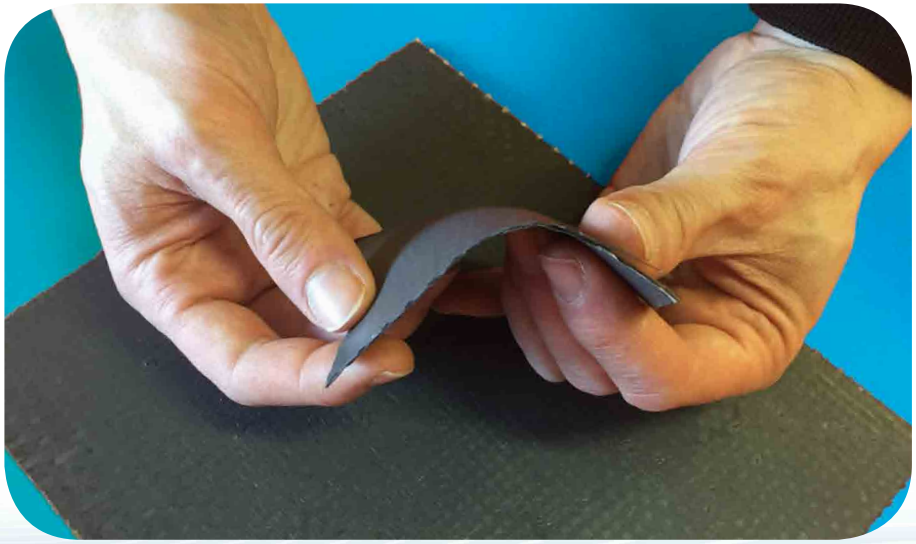



EEE-CFCC has the ambition of networking the background and know-how of ENEA-TEMAF, ISTEC-CNR, CERTIMAC, CIRI-MAM and ROMAGNATECH in the field of fiber-reinforced composite materials, to foster the innovation in this field, for industrial applications in the construction and transport sectors. All the research partners operate in Faenza, within the High-Technology Network of the Emilia-Romagna Region.

Currently, the composite industry produces **Polymer Matrix Composites** (PMC), using mainly standardized technologies and commercial prepregs; the absence of proprietary technology exposes these companies to competition risks and profitability reduction.

The project aims at developing technologies which exploit industrially available facilities to achieve products with new, unmatched functionalities, particularly regarding to high-temperatures and **fire resistance**. Within the project, pilot lines will be set up, able of producing full scale demonstrators (TRL 6) on which will be performed functional qualification, design employing thermal modeling tools and, when possible, tests simulating expected working conditions.

The high-temperature applications considered will be **heat shields, exhaust pipes, fire resistant insulating panels** to guarantee economic and environmental sustainability of new products and productions, LCA will be carried out, and several second raw materials and end-of-life solutions will also be studied.



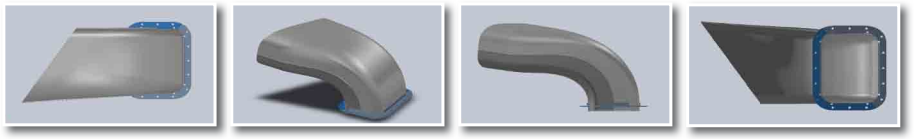
## GOALS

The project aims at unlocking new markets developing **novel technologies and disruptive innovation** within the **transport and construction** sectors, which are very well represented in the industrial partnership: namely, the polymer composite and chemical industry, the companies focused on thermal insulation and fire-resistance, the high precision mechanical industry and aerospace.

With regard to **secondary raw materials**, the project will study both biomass combustion ashes and different types of fibers obtained from pyrolysis of end-of-life polymer composites and prepreg production scrap and waste.

The new composite materials that will be studied and developed will be:

- fiber-reinforced **Ceramic Matrix Composites (CMC)** derived from **Preceramic Prepregs;**
- **dense and porous geopolymer composites.**



## ACTIVITIES

The polymer composites (PMC), typically used for the weight reduction in the transport sector, are not suitable at temperatures above 250°C as, for example, near the internal combustion engine or the braking system: to reduce weight of components expected to operate at high temperature, current approach is to introduce non-structural thermal insulation materials, which provide some thermal protection to conventional PMC.

This project approach is to exploit **Preceramic Polymers** for the low cost production (by **pyrolysis**) of light thermo-structural and thermal-insulating inorganic materials. These materials proved exceptionally effective also for fire protection and are reasonably cheap.

EEE-CFCC will develop previous results, obtained within the MITAI project (at the Faenza premisis of Ravenna Technopole), namely (1) the development of a new ceramic composite (CMC) called **BasKer**, to recall its chemical nature, being a **basalt-reinforced ceramic material** and (2) the development of geopolymers. BasKer can be processed as a PMC with conventional techniques and similar production costs, but can also be converted into a low cost CMC upon pyrolysis. BasKer-CMC combines a low specific weight (<1.9 g/cm3) with thermo-structural properties up to 600°C, along with resistance to fire and thermal insulation up to 1200°C.

The **porous geopolymers** can be associated and joined to BasKer foils to produce free standing fire resistant insulating panels and **REI doors**, while dense and fiber-reinforced geopolymers could be interesting to produce molds for the production of CMC in complex shapes.