GIANCE
Fused with Sustainability

Crossfire

GIANCE Project for innovation in Circular Recyclable Graphene based Crosspreg® reactive prepregs to Super-Lightweight bodies production

GRAPHENE FLAGSHIP

UK Research and Innovation

Funded by the European Union

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101119286 and UKRI under Grant Agreement No 10090645 and No 10101683.

Crossfire and GIANCE Project

- GIANCE Project offers innovative solutions to environmental challenges by developing the next generation of graphene and related GRM-based enhanced multifunctional, lightweight, recyclable materials, which present an exciting opportunity for the EU largest growing markets.
- Within GIANCE, Crossfire went developing the first generation of Circular Recyclable prepregs (Crosspreg®) graphene improved, to offer improved mechanical parameters at equal weight or equal at lower weight.
- The Graphene nanoparticles presence doesn't influence the EoL circular recycling of Crosspreg®, who went properly developed to prevent any H&S issue

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Crossfire Srl

- Applied R&D Laboratory dedicated to **Develop** and **Produce** innovative reactive prepregs, capable to give a solution to the latest requests of the “Net-Zero” economy.
  - **develop** and **license** the Crosspreg® dedicated transformation technologies and can make pre-series:
    - Mould shaped parts without size limits (Patent applied together with ENEA)
    - Sandwich panels (Patented)
    - Moving toward Circular Recyclable Resin Injection (in development)
  - **develop** and **apply** the 2-D nanomaterials into new Crosspreg® formulations (going to be Patented)
    - Super Lightweight moulded bodies
    - Moving toward Electronics

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Crosspreg®

- **Solid at RT**
  - No solvents; no Emissions; no refrigerated storage/delivery
- **Very low viscosity at molten stage**
  - About 10 times lower viscosity than a thermoset liquid resin; lower than capillarity limit level
- **Isothermal curing**
  - 160-180°C, 3 to 10 minutes depending on thickness and fabric type
  - About 1,5Kg/cm2 pressure
- **Thermoset up to Tg, Thermoplastic behave over Tg**
  - Thermoforms at about 200°C
  - Formula based Tg from 65°C to 125°C

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Crosspreg®

- No limits:
  - Basalt; Natural (cotton, linen, hemp,..); Aramide easy perfect impregnation
  - Pyrolysis Recycled carbon fabrics; no need of new sizing to performances like the virgin
  - Direct bonding to wood, metals, stones/ceramic, plastic films (PP, PET, PC, PBT, PE,..) in curing
  - Direct Tp over-molding in curing
  - Circular Recyclable at Secondary Raw Material high Value
    - Mechanical grinding + compounding in TP for injection/over-injection (ideal for GF)
    - Pyrolysis to full recovery of fabric and no sizing impregnation by Crosspreg® (ideal for CF)
    - Solvolysys to all Raw Materials recovery – back to monomers and solids
      - Graphene doesn't affect any of the above technologies, but Solvolysis only grants no nanoparticles release in the atmosphere

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Graphene related materials (GRM)

- GRMs are a broad category of carbon nanomaterials derived from **graphene;** a single layer of carbon atoms arranged in a **honeycomb lattice.**
- Graphene is the thinnest compound known at one atom thickness, **the lightest material** known (with 1 square meter weighing around 0.77 milligrams), **the strongest compound** discovered (between 100-300 times stronger than steel with a tensile strength of 130 GPa and a Young's modulus of 1 TPa - 150,000,000 psi), the **best conductor of heat** at room temperature (at (4.84±0.44) × 10^3 to (5.30±0.48) × 10^3 W·m−1·K−1) and also **the best conductor of electricity** known (studies have shown electron mobility at values of more than 200,000 cm2·V−1·s−1).

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- Within GIANCE, Crossfire is responsible to develop 2 automotive Use Cases :
  - The aerodynamic bottom shield of Maserati Levante, today in SMC/Carbon
    - To get it cheaper and lighter at equal performances at lower LCA/LCC
  - The spare wheel well of Jeep Renegade, today in steel
    - To get it lighter and cheaper at lower LCA/LCC
- The Graphene grade selected is GO from Graphenea
- The Crosspreg® selected resin is grade H95
  - Reactive Hybrid Epoxy/Polyester
    - The polyester component comes from recycling
  - Tg = 108°C

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Crossfire and GIANCE Project

- Crosspreg®GOGUd600
  - Glass UD 600g/m2 based – 5 plies
  - 300gr/m2 Resin H95 added with 0,2% GO from Graphenea

  - Run test plates 400x400x2,3mm
  - 3-point bending test at RT
    - 150x30x2,3 mm specimen
    - Span = 10mm

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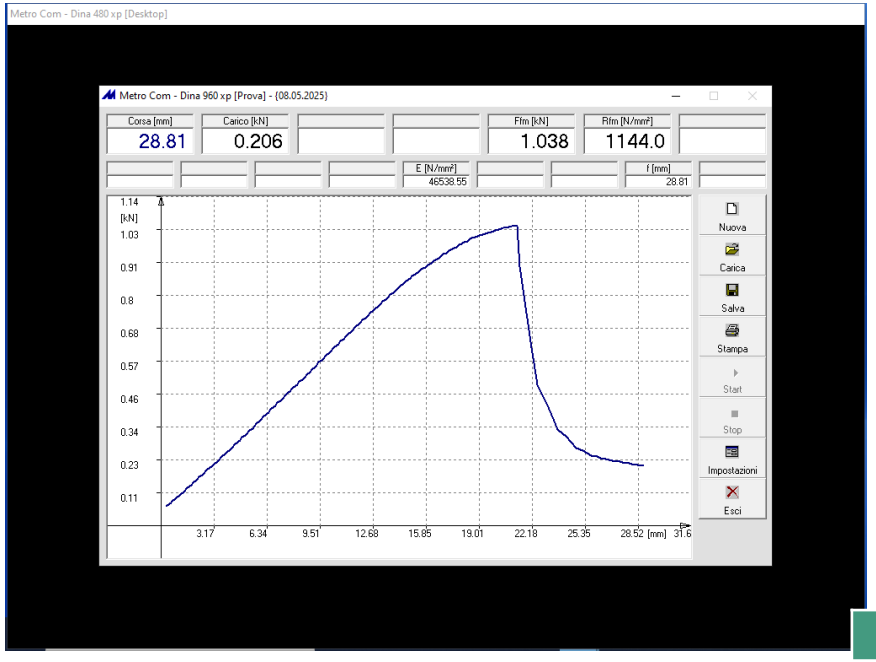
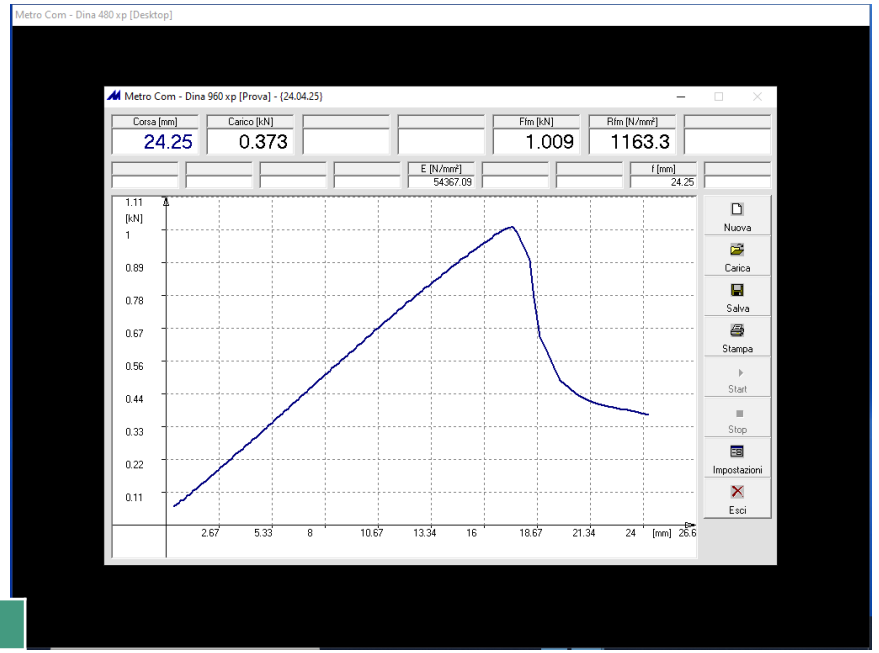
Crossfire and GIANCE Project



Glass UD



5xCrosspreg®GUd600 reference

	GO +2%	Reference
Deflection (mm)	22	17
Load (kN)	0,206	0,303
Ffm (kN)	1,038	1,009
Rfm (N/mm2)	1144	1163
E Modulus (N/mm2)	46639	54367

5xCrosspregGOGUd600

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Crossfire and GIANCE Project

- Wrap up data – GLASS UD with Graphene
  - Definitively higher Load/Deflection ratio
    - Higher load ….. about 50% higher
    - Lower deflection ……about 30% lower
  - Higher E-modulus (shear)
    - + 16%

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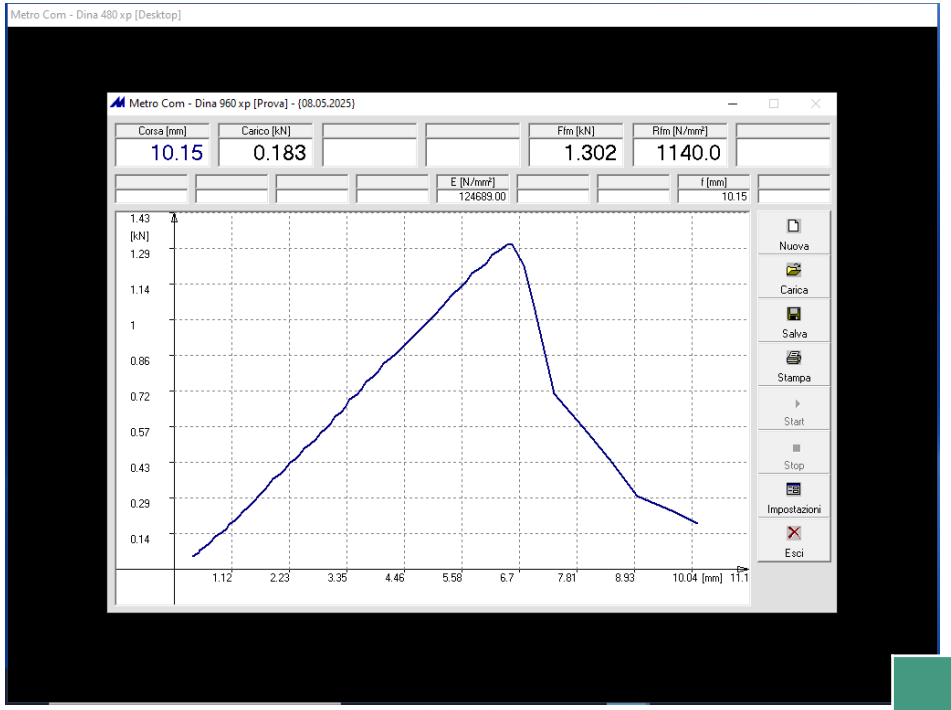
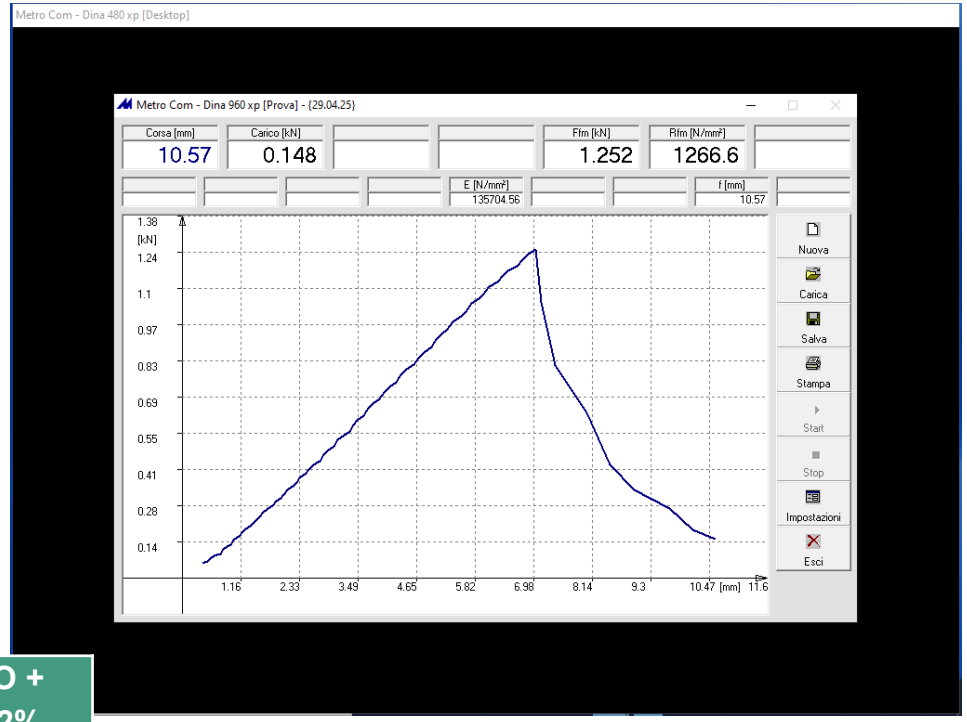
Crossfire and GIANCE Project



4xCrosspreg®CUd600 reference

Carbon UD



4xCrosspreg®GOCUD600

	Reference	GO + 0,2%
Deflection (mm)	6	6,9
Load (kN)	0,183	0,148
Ffm (kN)	1,302	1,252
Rfm (N/mm2)	1140	1266
E Modulus (N/mm2)	124689,9	135704,56

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Crossfire and GIANCE Project

- Wrap up data – Carbon UD with Graphene
  - No meaningful change in Load/Deflection
  - Slightly Increased E-modulus (shear)
    - + 10%

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- Conclusions :
  - The development is at its beginning and some more variables can influence the results; Graphene works by chemical bonds either with resin and fibers
  - The next variables to keep care of:
    - The sizing on fibres
    - The amount % of Graphene
    - The Graphene chemical functionality
  - Developments are in progress with Natural and Aramide fabrics

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Thanks for listening!

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