“Prodotti chimici, materiali, nuove tecnologie e innovazione industriale dei materiali compositi di nuova generazione, relativa legiferazione e circolarità”

Milano May 25, 2024

Crosspreg®

the Innovative Composite system, Mass productive, Hybrid reactive, Thermoplastic behaving, to lightweight in Circular Economy

lightweight engineering

we support you in the realization of
innovative, sustainable and **circular composites solutions**
from the first idea till production, through **Crosspreg®**

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Crossfire ….. Whom ?

- **Crossfire**, a very INNOVATIVE leader in composites technology
  Applied R&D :
  - Located in Solarolo, narrow the Faenza Composite pole,
  - Strictly connected with International Partners to joint Developments

CIRCULARITY …Why ?

- **By sure, we need to change our habits in term of Resources utilization**
  - Let us learn from history
    - Their uncontrolled usage leads to the end of resources
      - Let's project GREEN
    - But the "Greenwash" illusions bring to even worse damages
  - Science to be our teacher
    - The matter does not exist… anything is energy!
      - let's transform it without waste
    - Life is movement …. To translate a load we need energy
      - **the lower the load, the lower the energy demand**

- **We are conscious that, even if by small single actions, we can positively influence the Circular Technological Developments**

Prized on Circularity

Composites…Why ?

- **Composites are the best material to lightweight and, consequently, to a lower energy demand**
  - It's Anisotropic, that means giving the necessary only where it is necessary!
  - It can be produced by Renewable Raw Materials
  - Its End of Life can be recovered to a New Life by Low Energy Impact transformations, and high Secondary Raw material Value, higher than the Recycling costs
- The surrounding world is Composite !
  - It teaches us that any natural complex make downgrades into other natural valuable makes
    - Nature is Circular !

Circular Design

- **Up to today, most of the objects designed by humans, rarely had their Circularity in account**
  - It turned into incompatible materials bonded together just because of esthetical or construction needs
  - **Vice versa, the Circular Design, starts from the knowledge that it will live a second life, even if in downgrade. That means :**
    - Coupling of Compatible materials only
    - Simple Recycling Technologies at lowest cost and environmental impact
    - Max obtainable Value of the Recycled secondary Raw Material
    - And, based on the given product and not generic :
      - Mass Volumes rationalization
      - Any fragmentation makes the Circularity difficult and more expansive
- **Crossfire design Crosspreg® in Circularity, and Develop the dedicated transformation Technologies under the Mass Production Concepts, at minimum Energetical impact, no emission and environmental contamination**
- **Low LCA and low CO2 footprint**

MICHAEL ROBINSON

THE ECO ERA
CIRCULAR DESIGN

NEVER WASTE NATURE'S RESOURCES, BE THEY MATERIAL OR ENERGY
ALWAYS CONTROL POLLUTION THREATS IN EVERY PROCESS

1

IDEATION - DESIGN - ENGINEERING
USING NEW THOUGHT PROCESSES
- ECODESIGN
- EXPERIENTIAL DESIGN
- CIRCULAR DESIGN

2

MANUFACTURING
NON-POLLUTING ASSEMBLY PROCESSES
- FEWER COMPONENTS
- REVERSABLE CONNECTORS
- NO CO-MOLDING
- NO GLUING

3

PRODUCT LIFE
NON-POLLUTING DAILY USE
- ZERO EMISSIONS
- CLEAN ENERGY

IN THE FUTURE, EVERY FACTORY WILL BE HALF ASSEMBLE AND HALF DISSASSEMBLY

"CAR COLLECTORS" WILL NO LONGER EXIST IN THE FUTURE

"BUYING AND OWING" WILL NO LONGER EXIST IN THE FUTURE

4

END-OF-PRODUCT-LIFE = 100% RECYCLING
NON-POLLUTING DISSASSEMBLY + TRANSFORMATION

Crosspreg®

- **The bridge between the Thermoset reactive resin and the Thermoplastic Organosheet advantages**

  - It's a **solid** and **stable** PrePreg at **RT**
    - No need to keep it frozen (standard storage)
    - Very long Shelf Life (years)
      - Advantage in LCA

  - It's very **very low viscosity** at Molten stage
    - 10 times lower than a RTM/autoclave resin
    - It compenetrates the fabric by capillarity to 100% saturation
    - It calls for less press pressure processing
      - Advantage in LCA

Crosspreg®

- **The bridge between the Thermoset reactive resin and the Thermoplastic Organosheet advantages**
  - It's very **quick reacting** at 160-180°C
    - From 1 to 5 min depending on the fabrics
    - At isothermal condition
      - Advantage in LCA
  - **Easy PreForming**, at about 100°C, to a RT stable StageB
  - **Mass colourable**
  - **Direct bonding** to cores for sandwich construction
    - PET and rPET
    - Paper and Aluminum HC
    - Wood (from Balsa to Okumè ..) even as surface liner
      - Advantage in production simplification

Crosspreg®

- **The bridge between the Thermoset reactive resin and the Thermoplastic Organosheet advantages**

  - **Chemically Bonds to thermoplastic in curing**
    - Polyester and polyolefin surface films
    - Allows thermoplastic over moulding
      - Advantage in production simplification

  - No limits in the choice of **reinforcing fabrics**
    - Carbon; Pyrolysis Recycled Carbon; Glass; Basalt; Aramid …
    - rPET; Linen; Cotton; Hemp; Bamboo …
      - Advantage in production simplification

  - No Solvents; no Formaldeide; no VOCs; ….
    - No emissions
      - Environmental advantage

Crosspreg®

- **The bridge between the Thermoset reactive resin and the Thermoplastic Organosheet advantages**

  - **Crosspreg®** is based on **Patented Property Resins**
    - They are partly made by Monomers coming from Recycling and EC sourced only
    - Hybrid Polyester/Epoxy
    - Various Tg are available
      - Advantage in LCA and Circular Economy

Crosspreg®

- **The bridge between the Thermoset reactive resin and the Thermoplastic Organosheet advantages**
  - **Crosspreg®** is easy **to recycle in Circular Economy**
    - Depending on the article formulations
    - Based on the output Residual Positive Value
      - **Mechanical grinding and compounding** in thermoplastic Polyesters for Injection moulding
        - Ideal for Glass fabric based Crosspreg®
      - **Solvolysis** in Hot Glycol (PET bottles like recycling process) to recover the monomers to a virgin PET and, separately, the fabric, to a new usage
        - Ideal for high polyester content resin grades
      - **Pyrolysis**
        - Ideal for Carbon fabric based articles
        - The recovered fabric can become a new Crosspreg® with close to virgin properties
  - Advantages in LCA and Circular Economy

MICHAEL ROBINSON

THE ECO ERA
ECOTECHNOLOGY

CROSSPREG IS AN EXCLUSIVE AND INNOVATIVE COMPOSITE MATERIAL WHICH REDUCES DAMAGE TO ECOSYSTEMS COMPARED TO TRADITIONAL TECHNOLOGY
WE MUST TAKE INTO CONSIDERATION THE FULL LIFECYCLE OF EACH MATERIAL, PROCESS, AND END PRODUCT

GREEN TECH WITHOUT GREEN WASHING

REALISTIC PLANS FOR SAVING THE PLANET

CROSSPREG®

SUSTAINABLE UPSTREAM MATERIAL SOURCING AND PREPARATION
LOCAL PROCUREMENT AND STORAGE

SUSTAINABLE MATERIAL TRANSFORMATION
LOW ENERGY USE + NO SOLVENTS
ZERO EMISSIONS
ALL DISCARDS ARE RECYCLED AND REUSED
TOOLING IS GREATLY REDUCED
INFINITE SANDWICH VARIATIONS

SUSTAINABLE DAILY END PRODUCT USE
LIGHTER WEIGHT - STRONGER STRUCTURE BACTERIA-FREE SURFACE TREATMENT
FASTENERS CAN BE GREATLY REDUCED
100% FORMALDEIDE FREE

SUSTAINABLE PRODUCT END-LIFE
100% RECYCLABLE & REUSABLE

EIT Raw Materials Co-funded by EU

FENICE
Fire Resistant Environmentally Friendly Composites

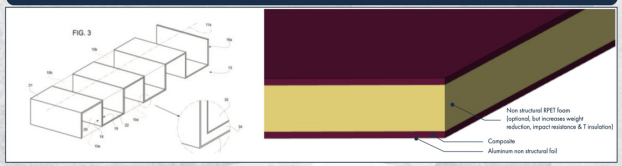
This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Program for Research and Innovation.

With the external collaboration of nalucoat

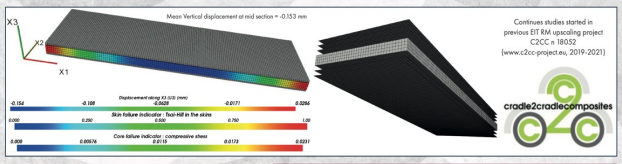
The Nalucoat idea started from a group of people with multidisciplinary and complementary background, while writing a book about Ecosustainable Design. The book, edited with the collaboration of the well know automotive designer Michael Robinson, was followed by nalucoat® registration and the creation of manufacturing startup with the same name, working on the same concepts and Nanoprom Chemicals formulations for surface "vitrification".

In parallel to the first 12 months of FENICE, Nalucoat process demonstrated that treated Al have the same corrosion resistance of Cr-plated one and much lower C-footprint (about 1/5) with a number of advantages of fundamental interest for FENICE project targets (full recyclability of treated Al, no combustible materials added, no health hazards and no toxicity, thermal stability up to 800°C, no combustible materials added, no possible source of microplastics). Cr-plating was banned by EU Directives in September 2023 from further use in the aesthetical applications in the automotive, although an official date has not set yet.

FENICE aims to achieve weight reduction in comparison to steel battery boxes, using FML and innovative composites, instead of light alloys with several advantages in terms of sustainability & safety. The project is developing prepregs and SMC as semifinished products, for reducing manufacturing costs and increasing reliability. These prepregs will be associated with thin metallic foils, with no structural function, so recycled Al can be used. Both prepregs and metallic foils can be circular-recycled, in line with EU Directives about EOL reuse of automotive materials. Glass and basalt will be the fibres of choice, to avoid non-recyclable and high embodied energy C-fibres.
FENICE will develop the engineering for a patented novel-battery-box-concept, optimising for the final target production of 0,8 - 1 million pieces per year by 2032 (starting from 80k in 2029). This implies that assembly, disassembly and recycling will have to be investigated for all the adopted materials with an industry driven approach. Several high sustainability resins are being investigated, with specific focus on biobased resins, C2C recyclable and reactive thermoplastics. At the end of life, 90% of the employed materials can be closed loop recycled (reused for the original applications) with low energy demanding processes.



EXAMPLE OF VIRTUAL CHARACTERIZATION OF SANDWICH STRUCTURES IN THE AUTOMOTIVE



FENICE showed that both C2C recyclable resins and Biobased ones needs the Fiber Metal Laminate structure to achieve good fire resistance (residual flexural strength after fire simulation in conecalorimetry, 10 min at 700 ° C, 55kW/m2)

Materials	SMC preperg	Long fibers prepreg	
Fibre/Fabric	600gsm of 24mm chopped basalt	600 gsm twill basalt fabric	
Tensile Strength 0° (MPa)	76,3	492	ASTM D3039
Tensile Modulus 0° (GPa)	17,5	27	ASTM D3039
Tensile Strength 90° (MPa)	77,5	465	ASTM D3039
Tensile Modulus 90° (GPa)	15,9	27	ASTM D3039
Compression Strength 0° (MPa)	89,3	89	ASTM D6641
Compression Strength 90° (MPa)	88,6	94	ASTM D6641
ILSS (MPa)	11,9	16,8	ASTM D2344

In some cases, FML structure ensure 75% of residual flexural strength after fire exposure, even without the addition of fire retardants.
Processes are being implemented to max Al adhesion & minimize production costs and times.

	average Flex strength (Mpa)			average Flex Modulus (Mpa)		
samples	before cone test	after test 50Kw	after test 60Kw	before cone test	after test 50Kw	after test 60Kw
Cross5 and 7	475+/- 36,5	314+/-41,4	284+/24,54-	21100+/-939,68	13700+/- 2278,16	15400+/- 1787,63
Cross6 and 8	328+/-53,16	255+/-71,81	22,2	18400+/-685,57	13900+/- 2566,71	4360+/- 4,71

ENEA certimac ISSMC CRF CENTRO RICERCHE FIAT MICROTEX
Crossfire gemmate Gaiker GS4C université de BORDEAUX

Visit the Fenice website

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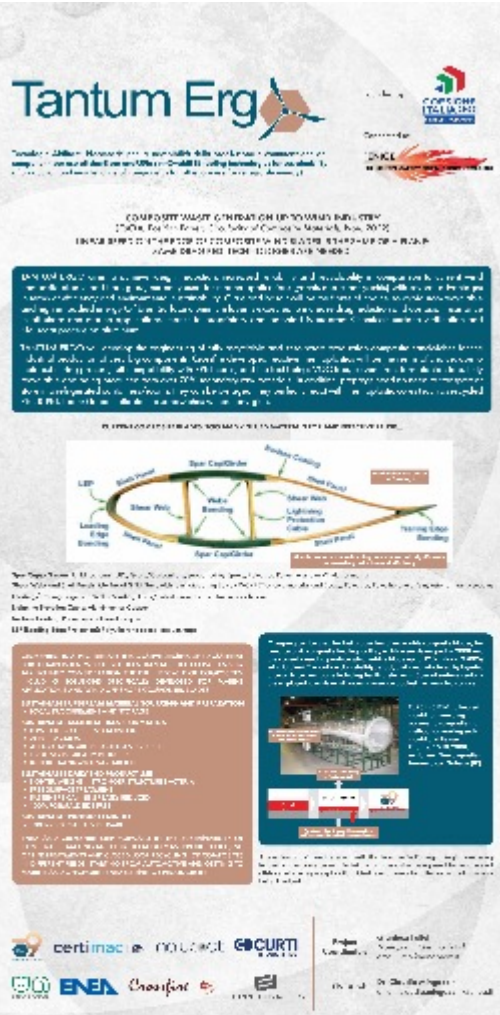


Emilia Romagna POR projects based on Crosspreg® technology

octima

Crossfire

GIANCE
Fused with Sustainability

HORIZON-CL4-2022-DIGITAL-EMERGING-02-20-2D
material-based composites, coatings and foams (IA) Part B

Graphene AllIANCE for Sustainable Multifunctional Materials to Tackle Environmental Challenges

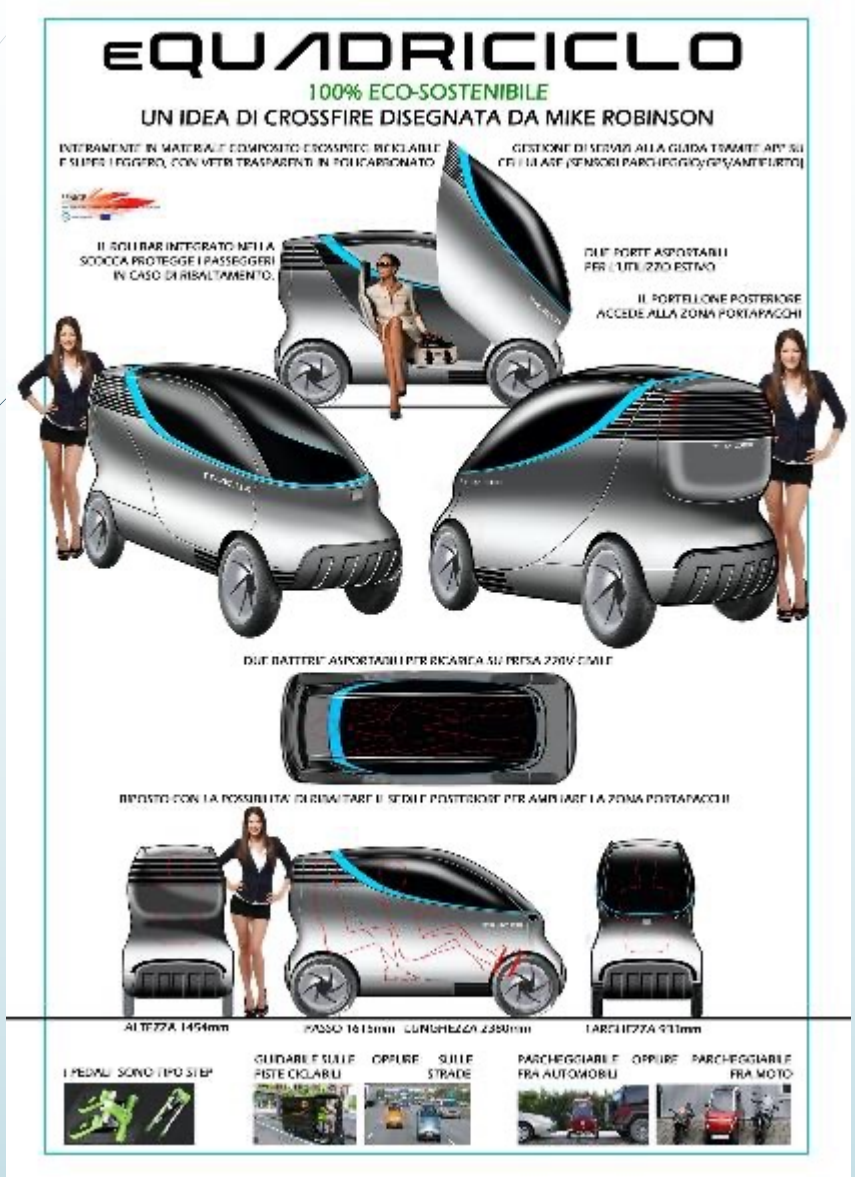
GRAPHENE FLAGSHIP

Crossfire is a Graphene Flagship partner

Crossfire develops Graphene improved Crosspreg® grades to Automotive and Aviation applications

octima

MICS (Made in Italy Circolare e Sostenibile)
Project Applied



3 Crosspreg® sandwich shells assemble the body
2 Crosspreg® sandwich shells removable doors

Some examples-automotive

- Structural shell: 1mm thickness by 4xCrosspreg®GTw345

Crosspreg® adheres thermoplastics

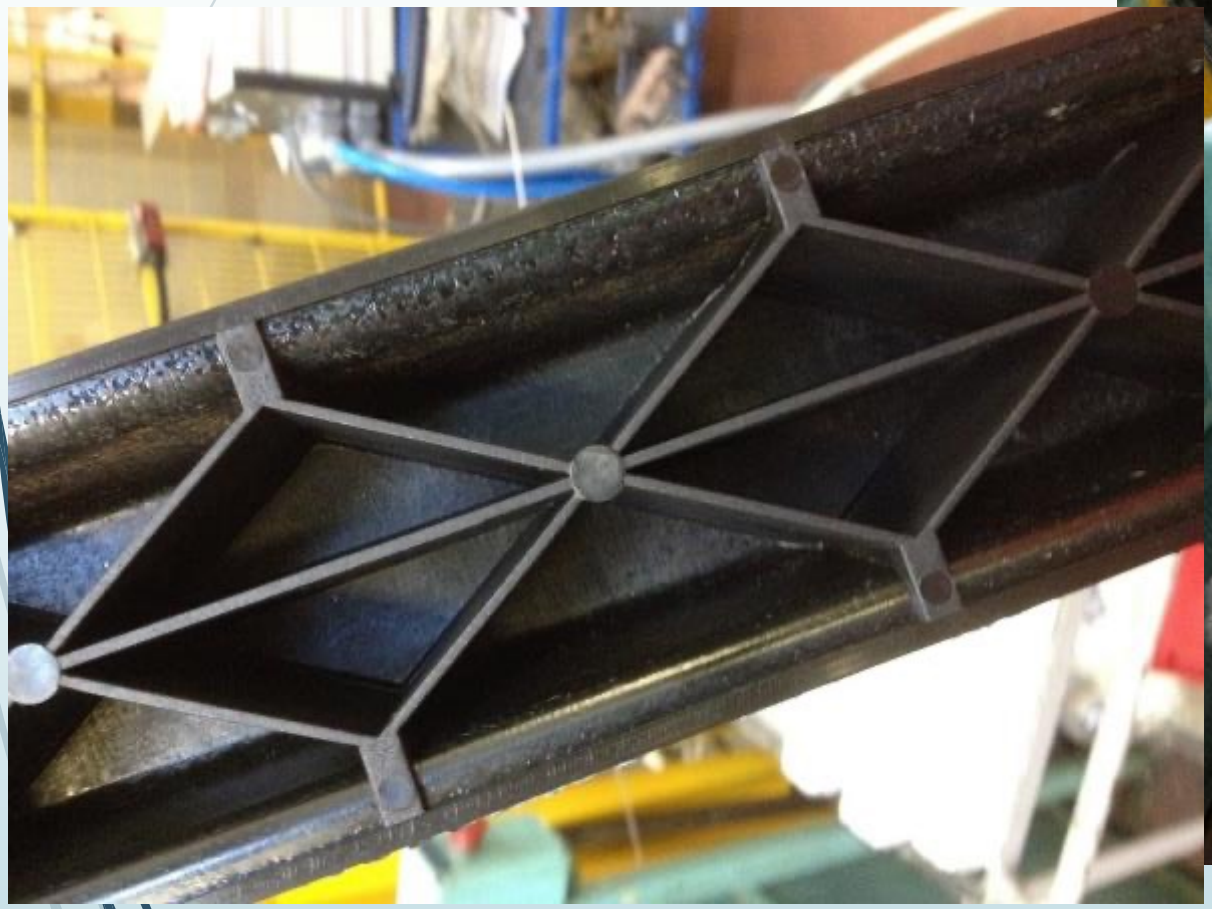
Study for a OverMoulded underbonnet arm:

Crosspreg®GTw600PP(White) PP surfaced

OverMoulded : PPGf30

Study for Overmolding

Crosspreg®GTw600 by PA6 with carbon powder reinforcement



Crosspreg® adheres Okume wood

SIP single step production

Study for a structural light Surf board:

Skins : Crosspreg®GTw220

Core: PET150 by Armacell

EcoVP-Tech : 1-5mm

Study for a structural light sport seat:

Skins : 6x Crosspreg®GTw220

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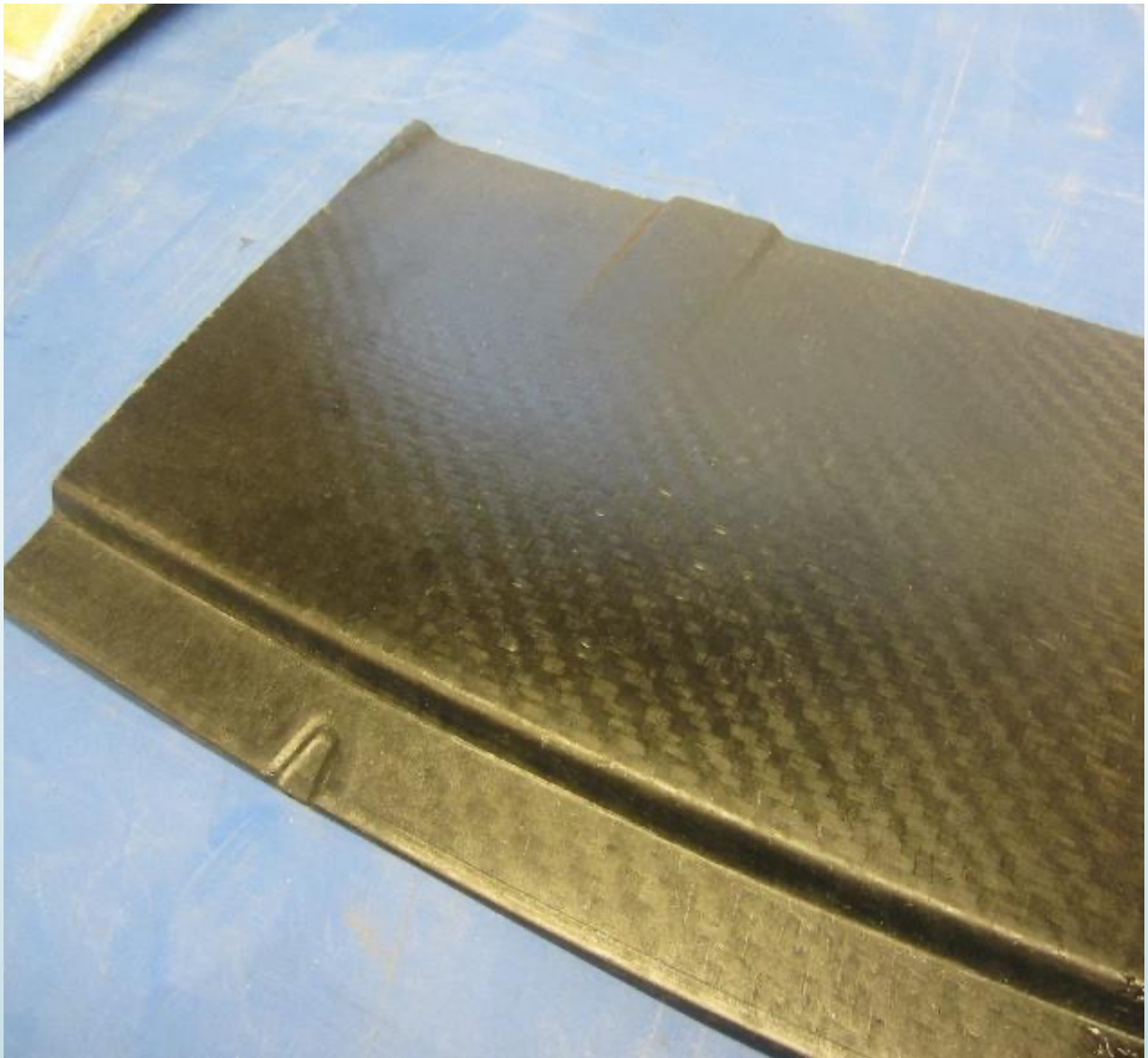
Study for a car roof and an aerodynamic bottom shield

EcoVP-Tech 1 to 8mm

Skins: Crosspreg®GTw345

Core : PET150 Gr Type

GIANCE Project



Study for a spare wheel case

Skin:

Crosspreg®GTw600

Surface aesthetic layer

GIANCE Project

THANK YOU !
For Your attention

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