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List of Tables

Figures and tables for **summary description of the project context and the main objectives**

Figure 1: different functionalities integrated in a single load-bearing material

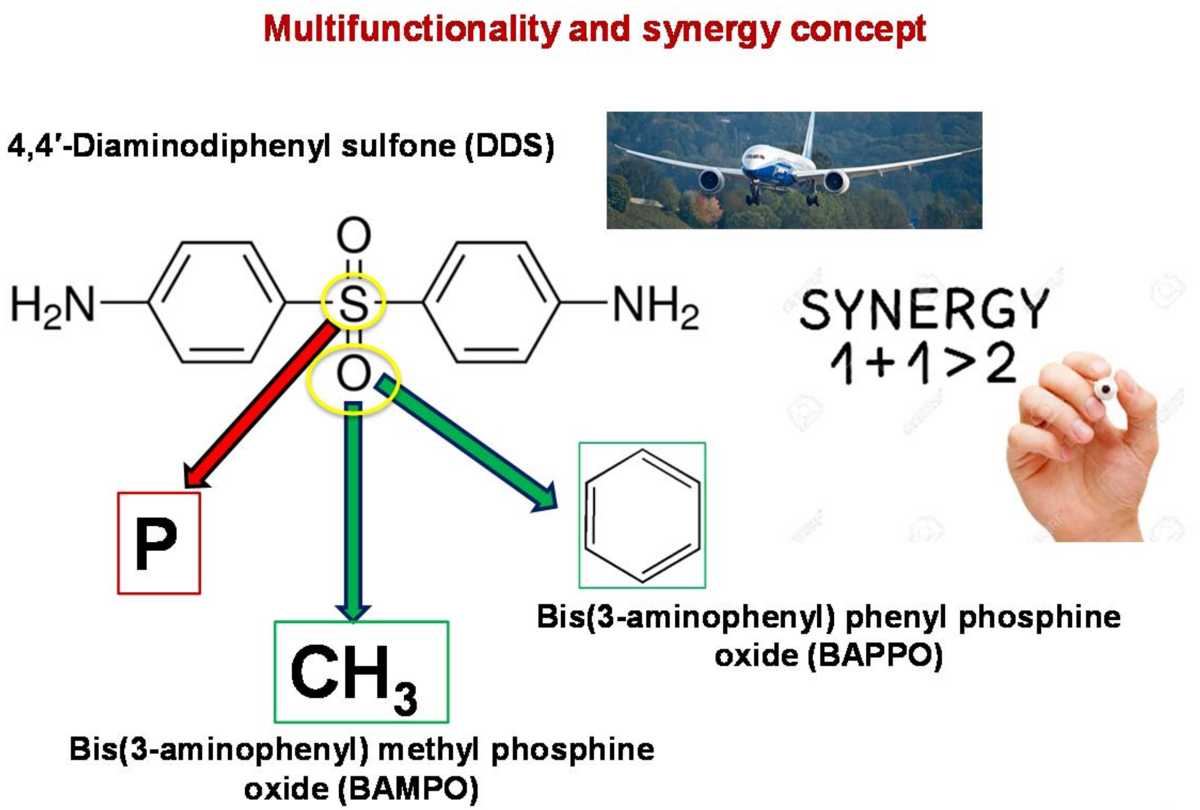


Figure 2: multifunctionality and synergy concept

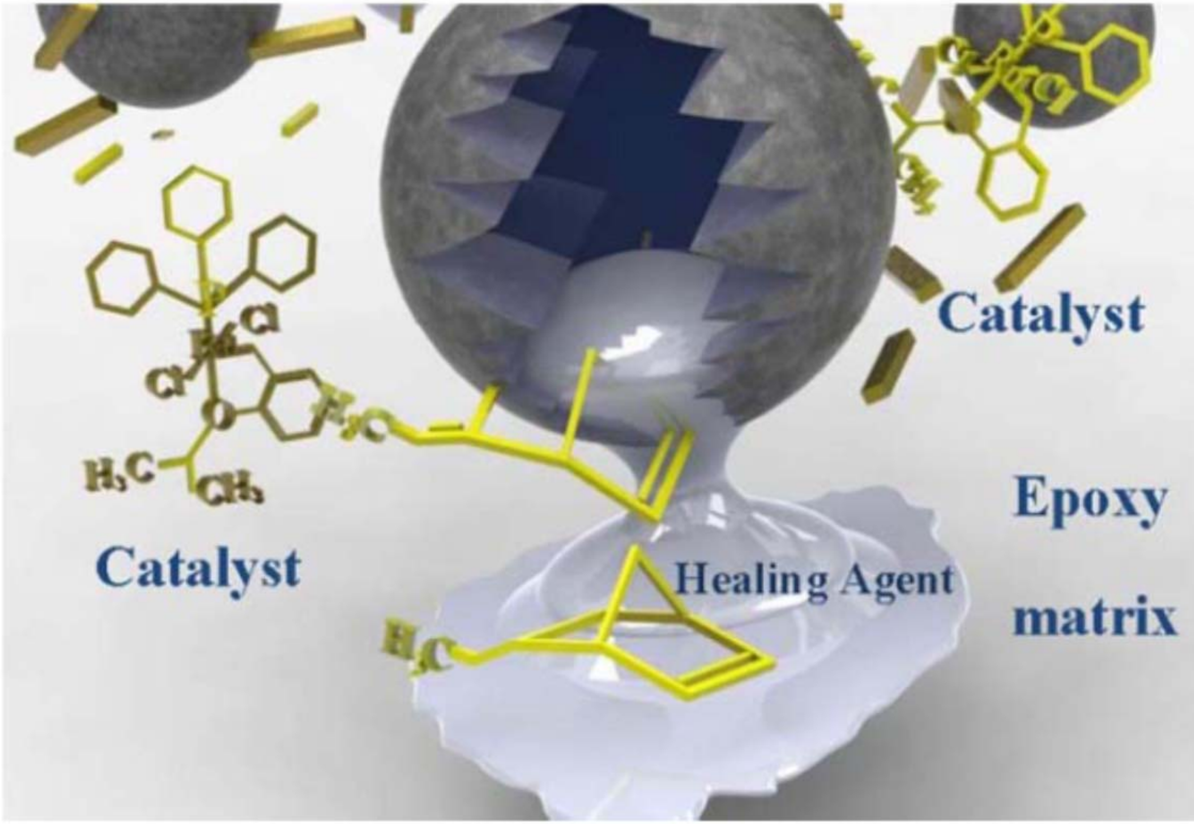


Figure 3: self-healing materials based on the "microencapsulation" concept

Functionalization of Carbon nanotubes with catalysts active in ROMP reactions

Electrical conductivity and self-healing functionality

Grubbs catalyst 2nd generation (G2) and Hoveyda-Grubbs catalys covalently bonded on the wall of MWCNTs.

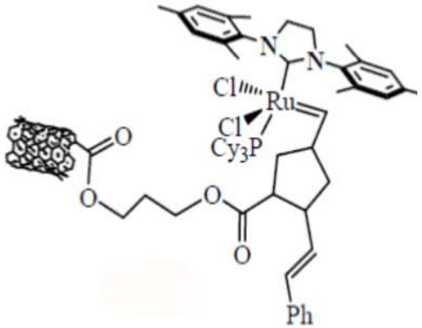


Figure. Carbon nanotube functionalized with Grubbs catalyst 2nd generation ($MWCNT\text{-}G2_{pr}$).

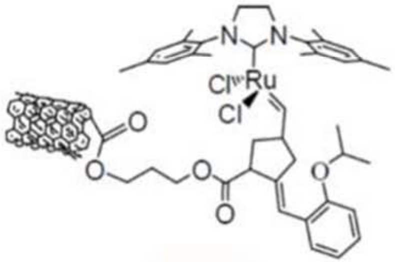


Figure. Carbon nanotube functionalized with Hoveyda-Grubbs catalyst 2nd generation (HG2).

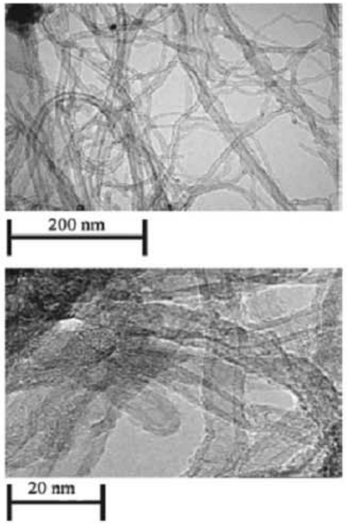
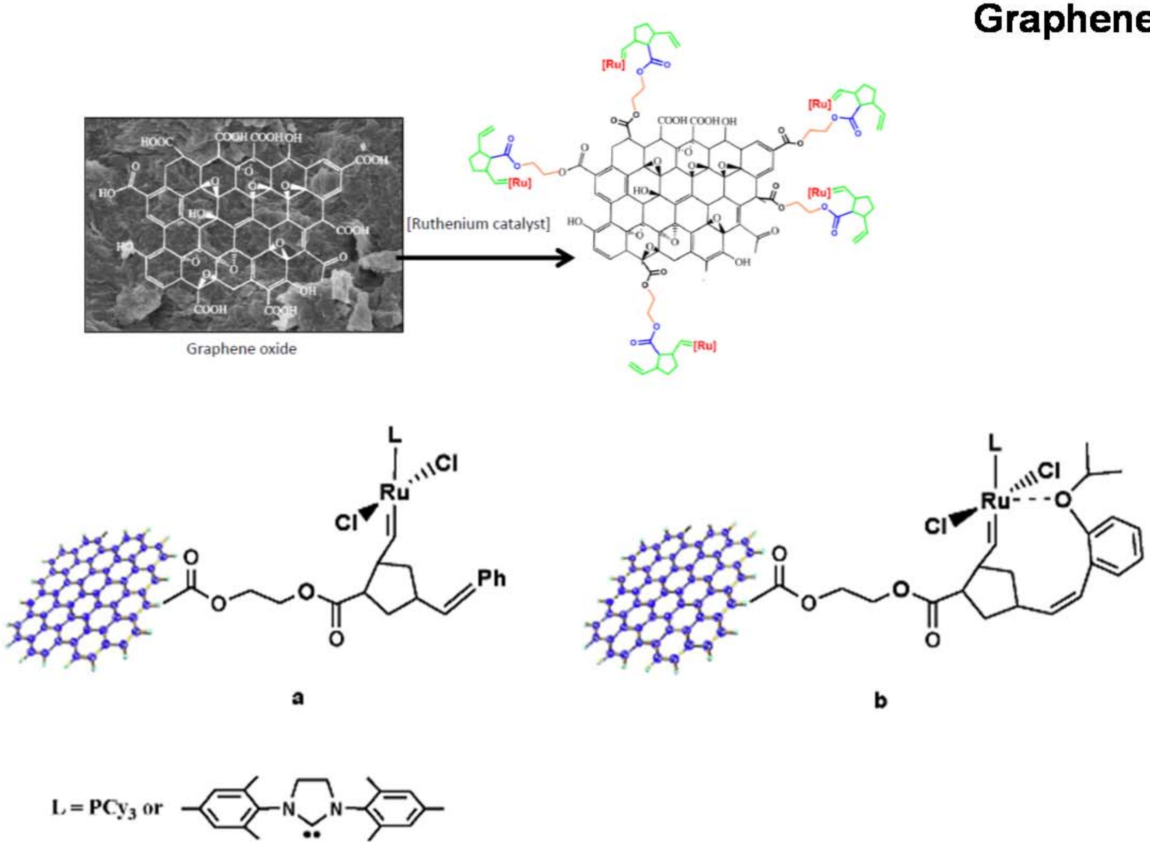


Figure. High resolution transmission electron microscope images of the MWCNTs

Figure 4: Catalysts for ROMP reactions covalently bonded to the walls of CNTs

Auto-repair function – design and research strategy

Graphene sheets



Catalysts for ROMP polymerization were covalently bonded to graphene sheets.

The catalyst activities were tested in reactions of ring opening metathesis polymerization (ROMP) of 2-norbornene and 5-ethylidene-2-norbornene.

This work started with the preparation of graphite oxide (GO) followed by the functionalization with ruthenium catalysts.

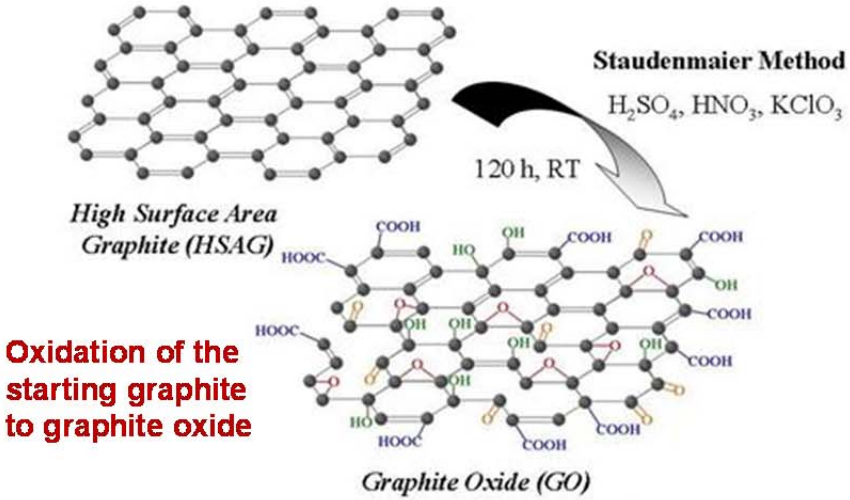
Figure 5: Catalysts for ROMP reactions covalently bonded to graphene sheets

Auto-repair function – design and research strategy

Modified Graphene

Preparation of Graphite oxide (GO)

The starting graphite (G) is a high surface area graphite (trade name Synthetic Graphite 8427) from Asbury Graphite Mills Inc., with a minimum carbon wt % of 99.8 and a surface area of 330 m^2/g.



Graphite oxide was prepared by Staudenmaier's method,[2] from the high surface area graphite (HSAG).

2) Staudenmaier, L. Ber. Dtsch. Chem. Ges. 1898, 31, 1481−1487.

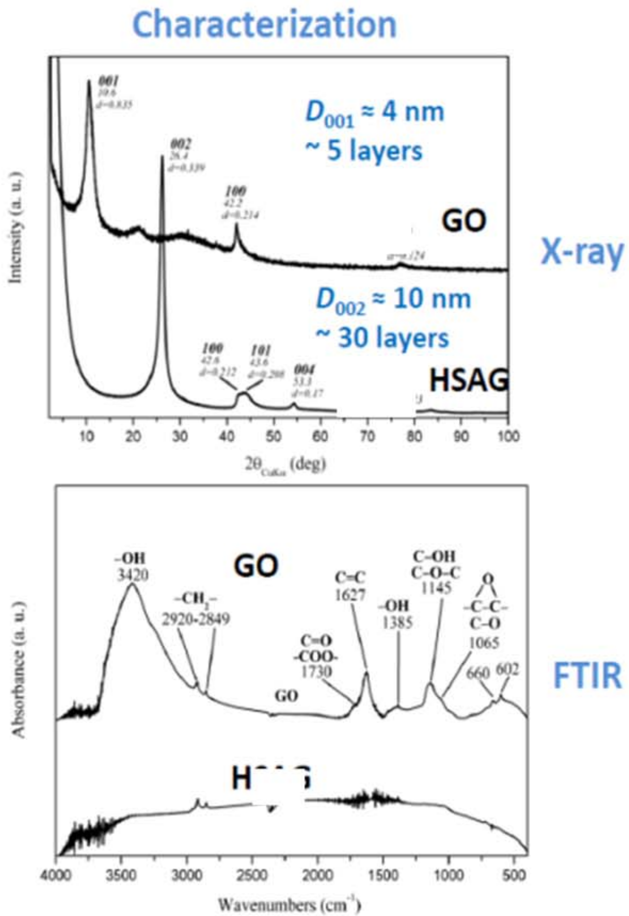


Figure 6: preparation of the graphite oxide used for the functionalization of ROMP catalysts

Electrical conductivity function : design and research strategy

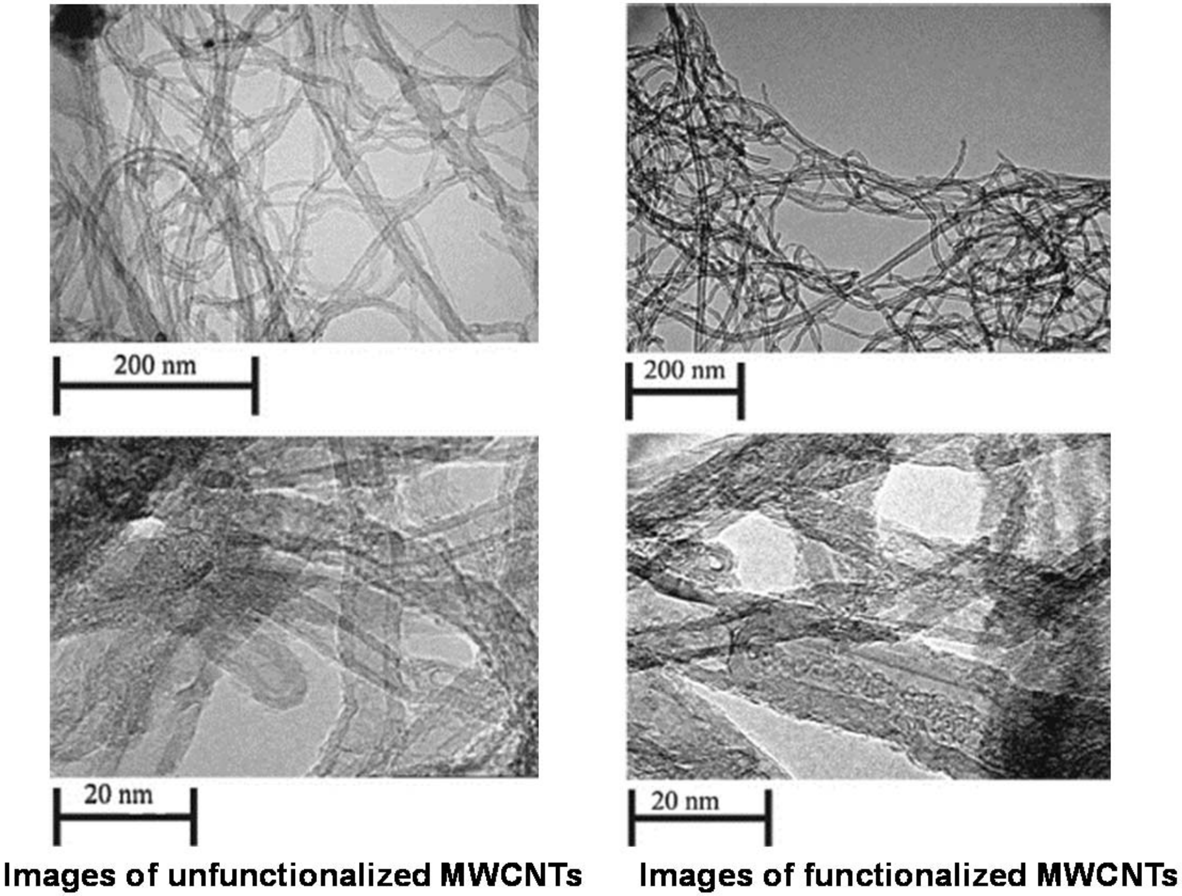


Figure 7: unfunctionalized and functionalized used as electrical conductive filler in IASS resins

Electrical conductivity function: design and research strategy

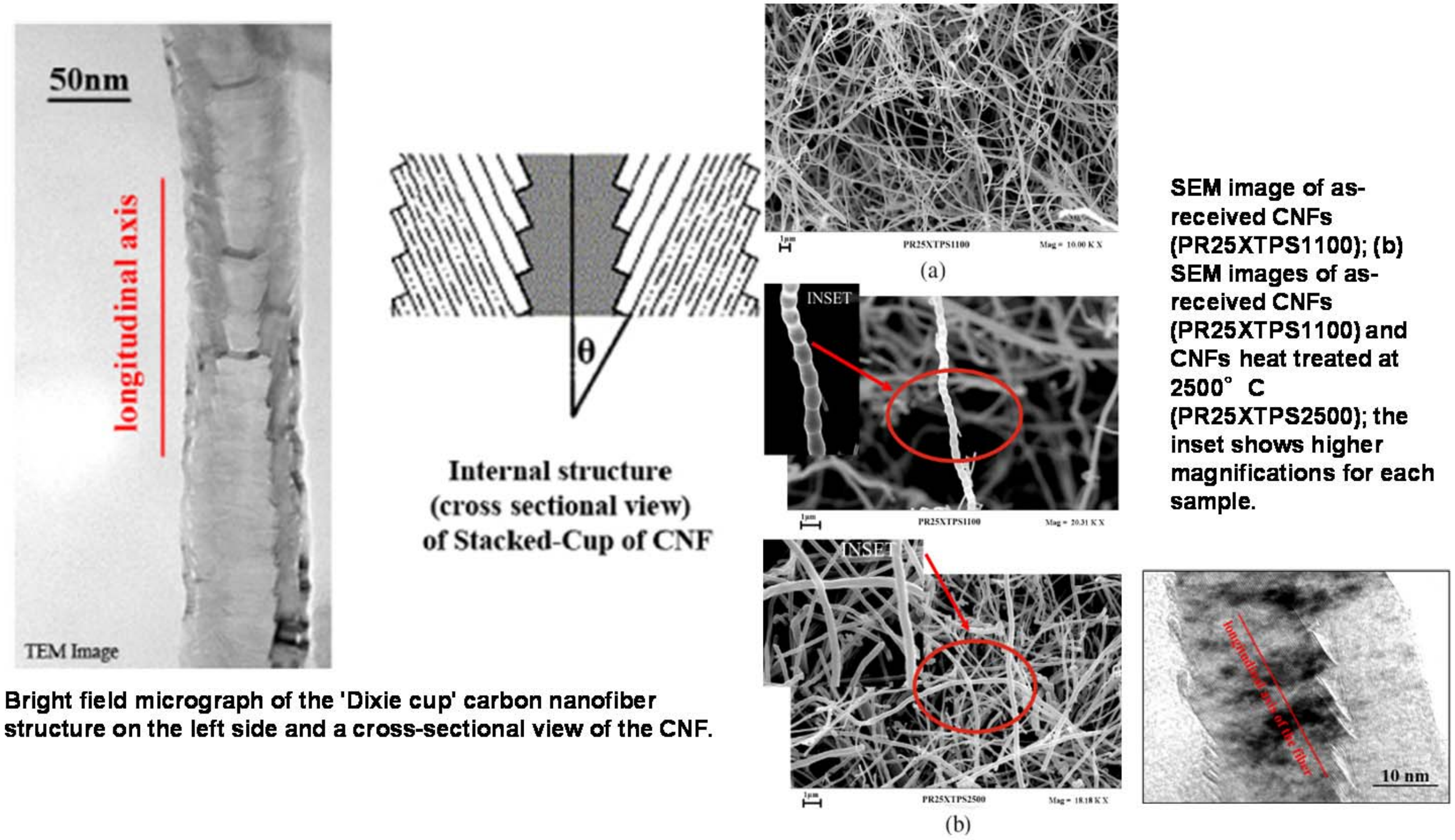


Figure 8: untreated and heat-treated CNFs used as electrical conductive filler in IASS resins

Electrical conductivity function: design and research strategy

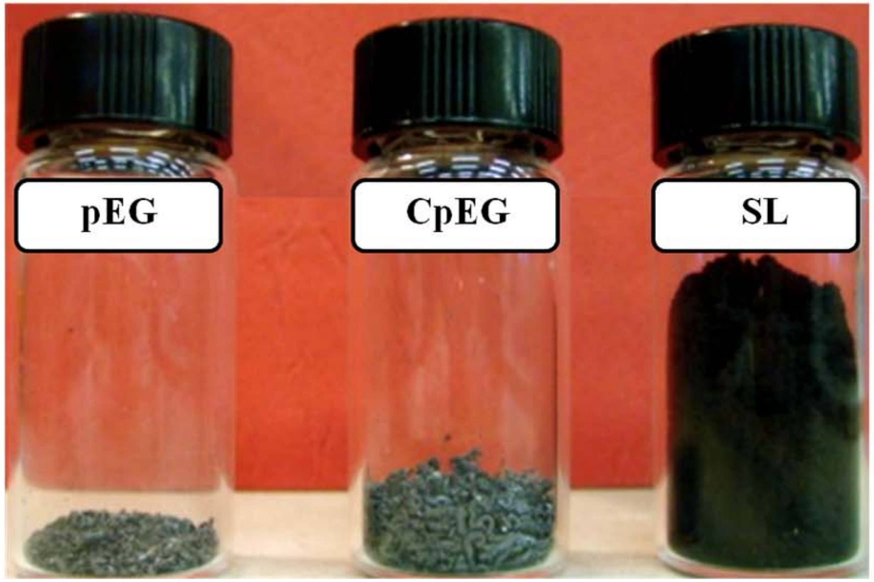
Graphene sheets

Three samples of graphene-based nanoparticles have been analyzed:

1) partially exfoliated graphite (pEG);

2) carboxylated partially exfoliated graphite (CpEG);

3) fully exfoliated graphite (SL).



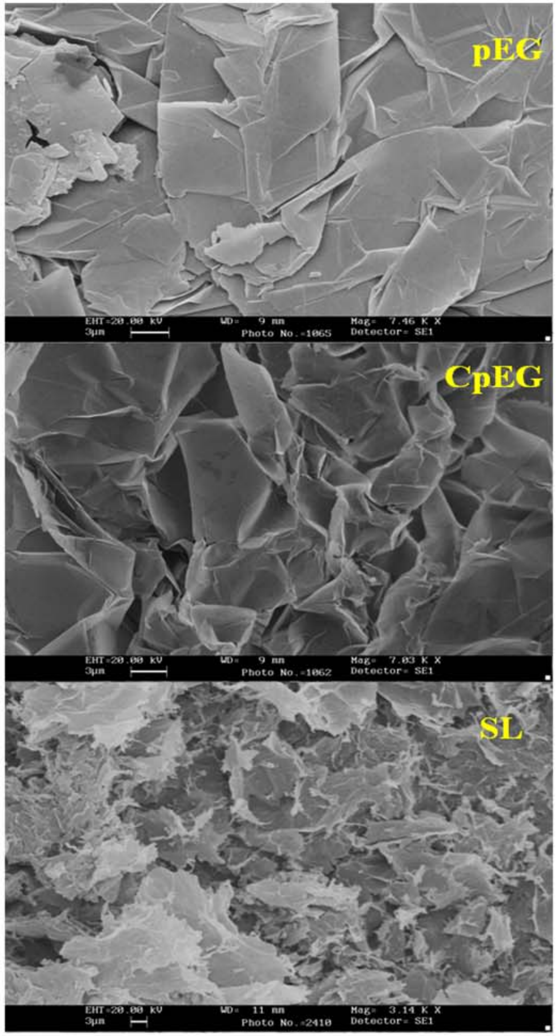


Figure 9: graphene-based nanoparticles used as electrical conductive filler in IASS resins

Enhanced flame resistance function : design and research strategy

- ***Identification and Synthesis of new Hardener Agents***
  - *Bis(3-aminophenyl)methylphosphine oxide (BAMPO)*
  - *Bis(3-aminophenyl)phenylphosphine oxide (DAPPO)*

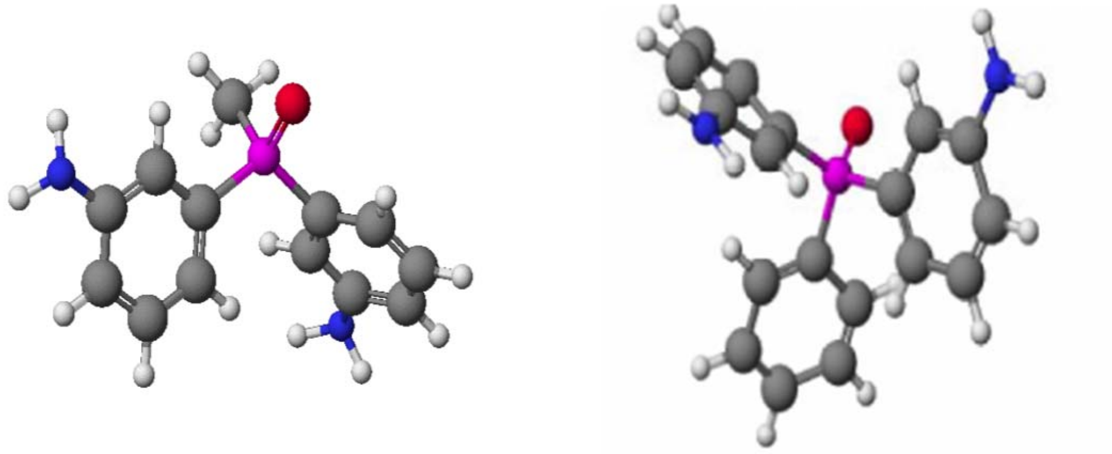


Figure 10: new hardeners agent (curing agents) synthetized to produce flame resistant composites

Figures and tables for **description of the project context and the main objectives**

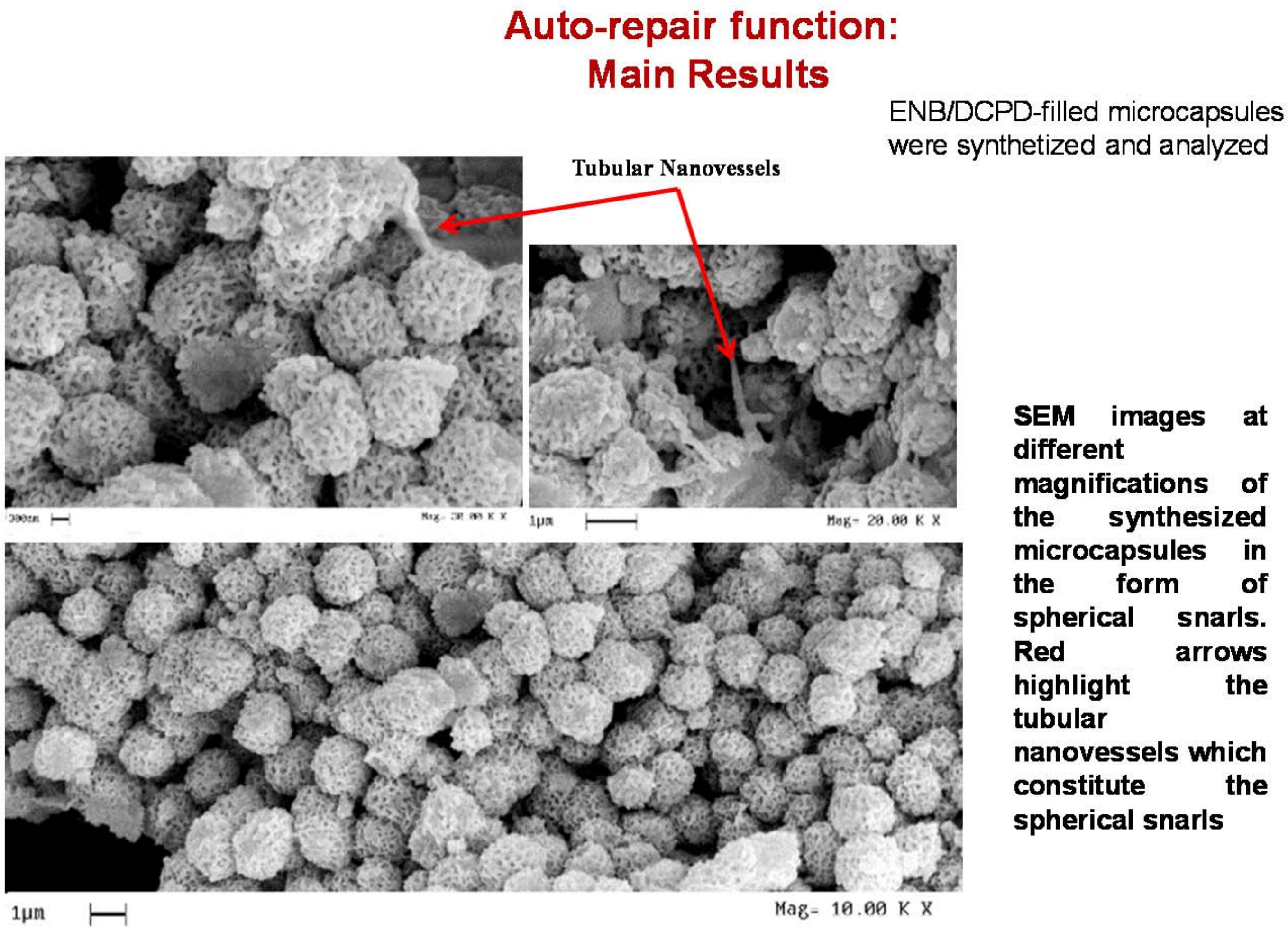


Figure 11: ENB/DCPD-filled microcapsules (in the form of spherical snarls)

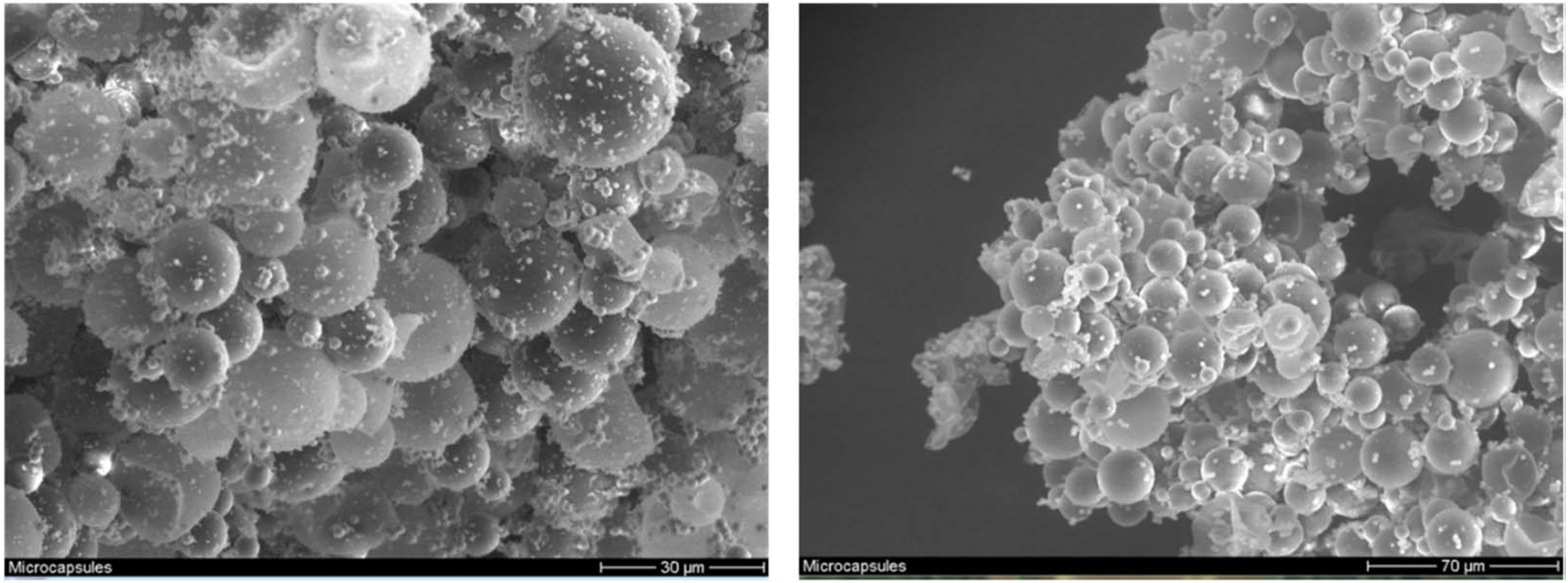


Figure 12: ENB/DCPD-filled microcapsules (in the form of spherical microcapsules)

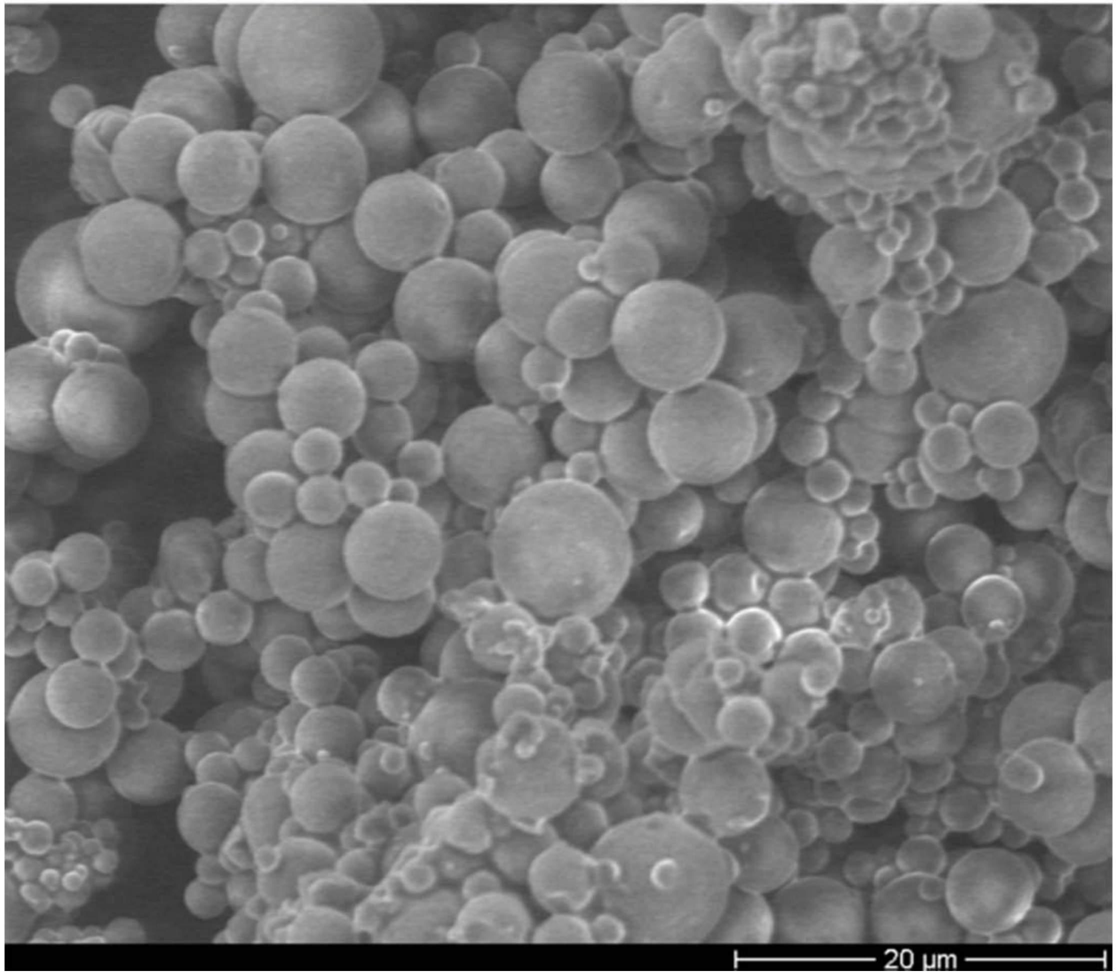


Figure 13: FE-SEM images of microcapsules containing Tri-Az-Ac

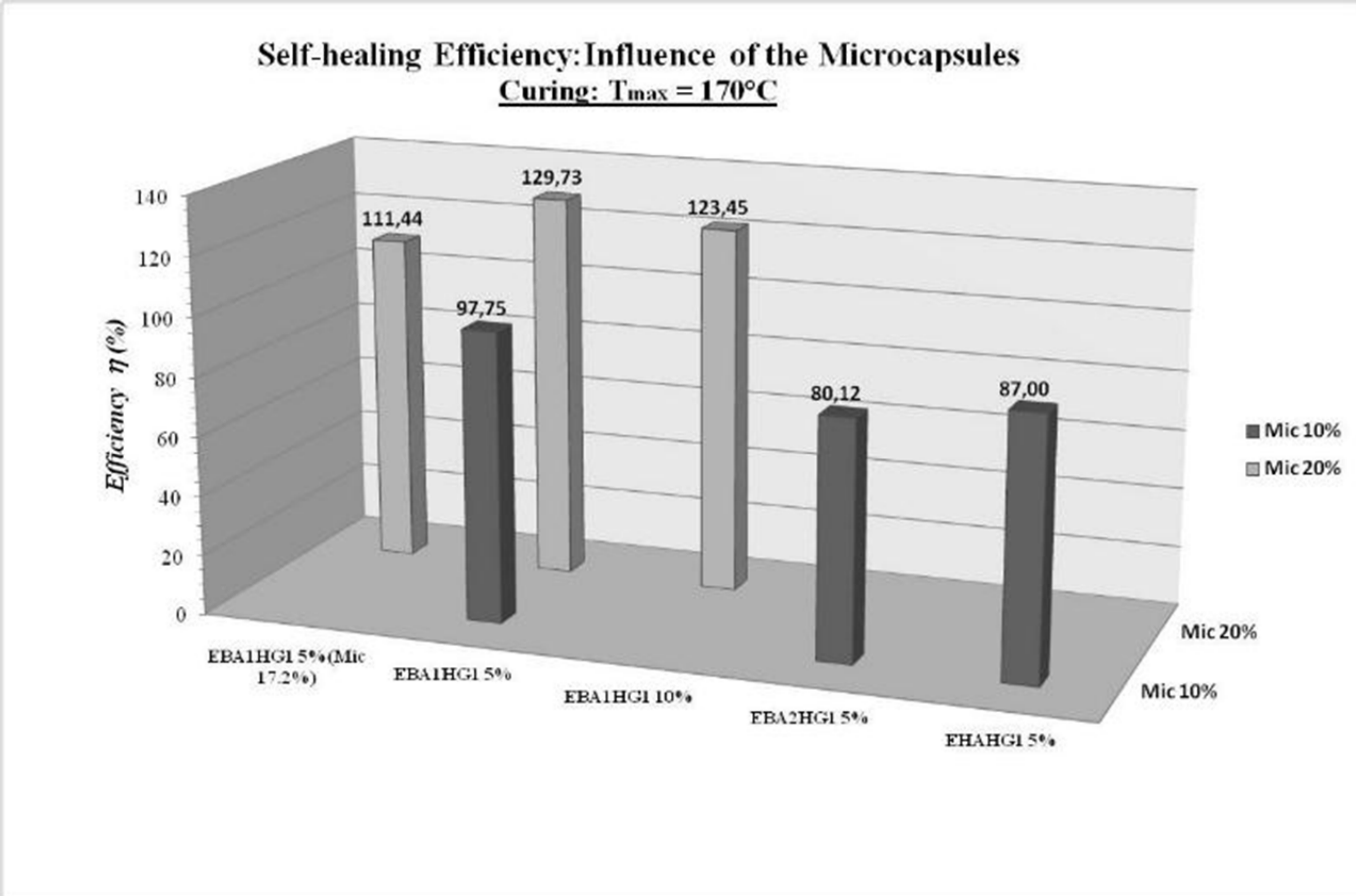


Figure 14: Self-healing efficiency-Influence of the microcapsules amount

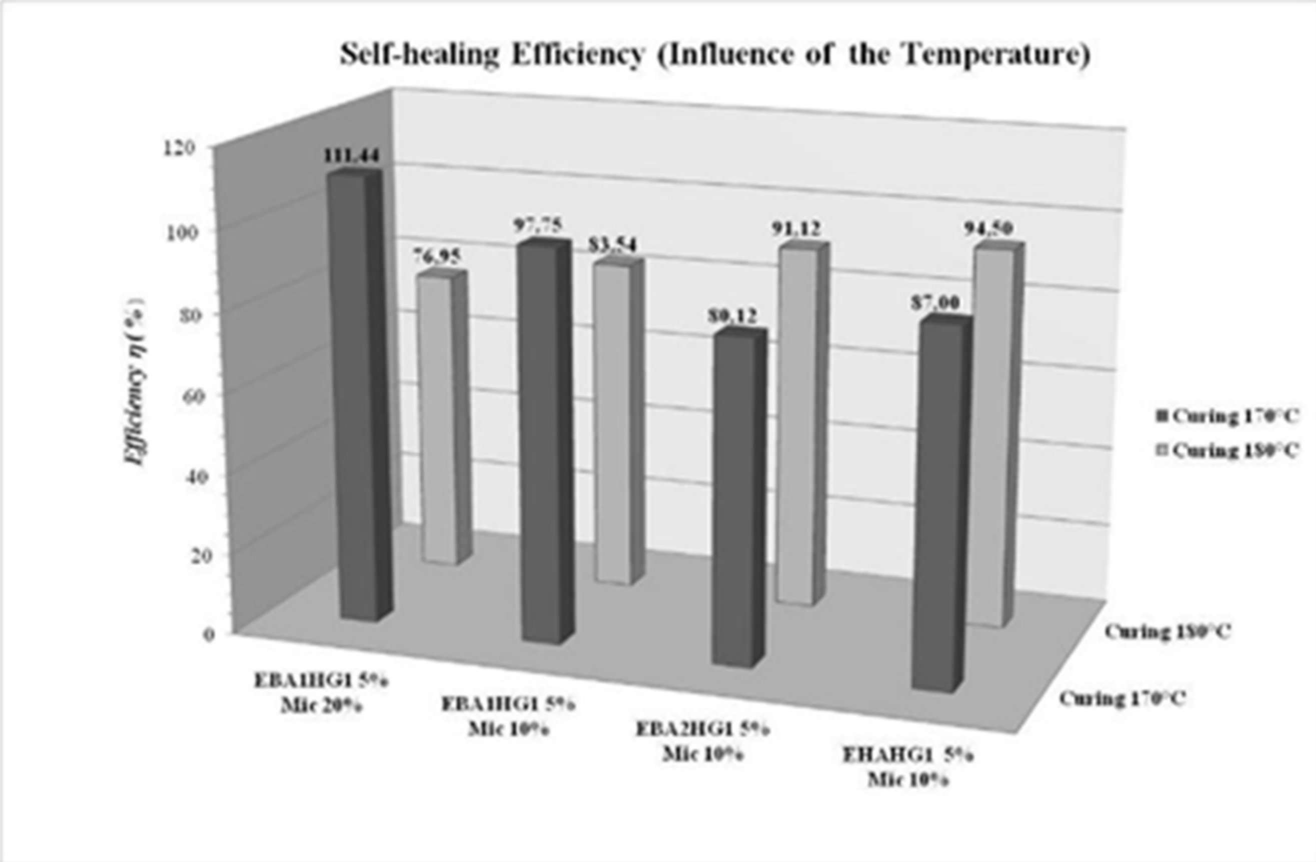


Figure 15: Self-healing efficiency-Influence of the curing temperature

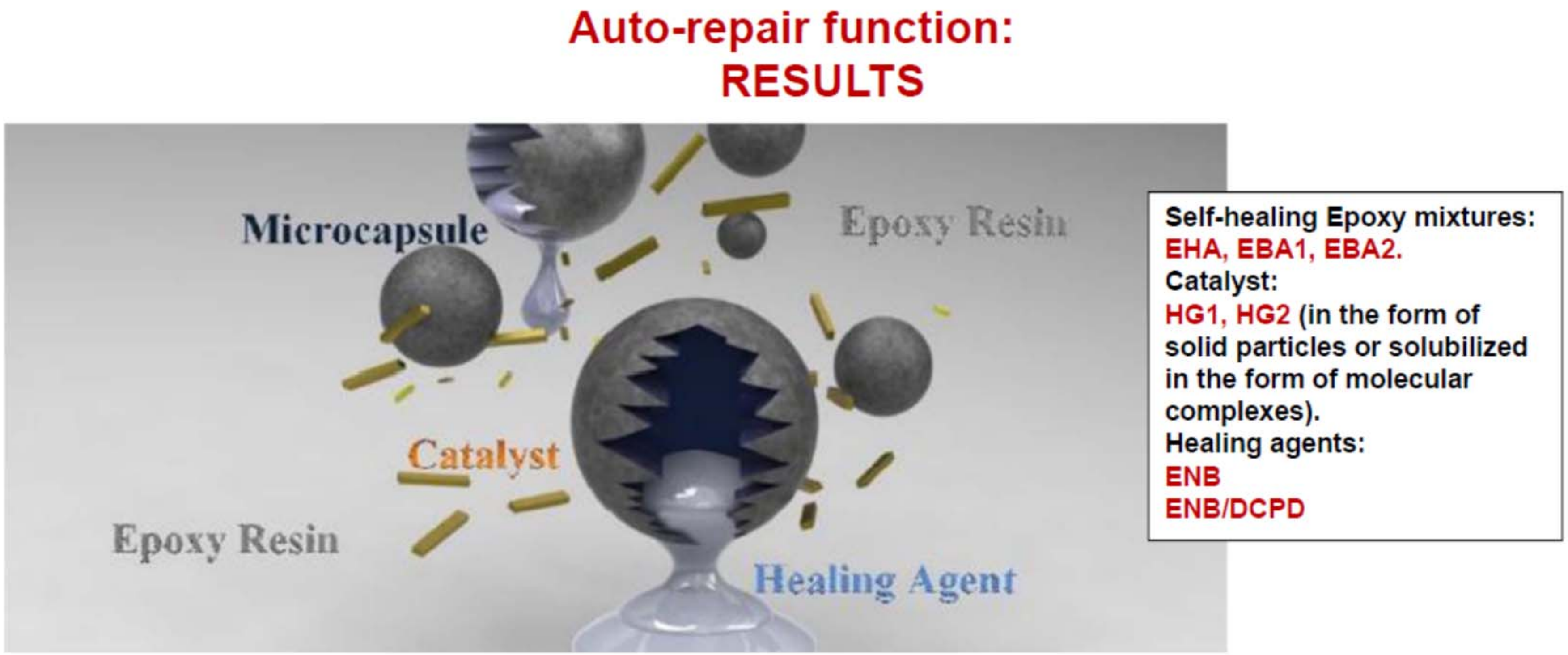


Figure 16: different composition of self-healing systems

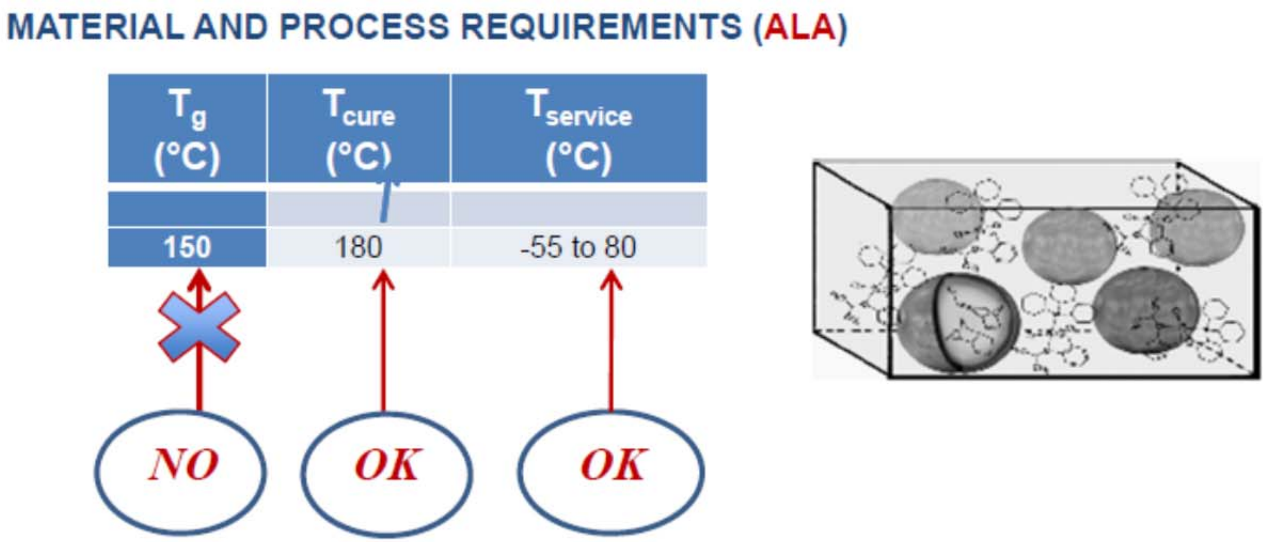


Figure 17: some of the mechanical requirements suggested by Alenia

Figure 18: scheme of the analyzed solutions

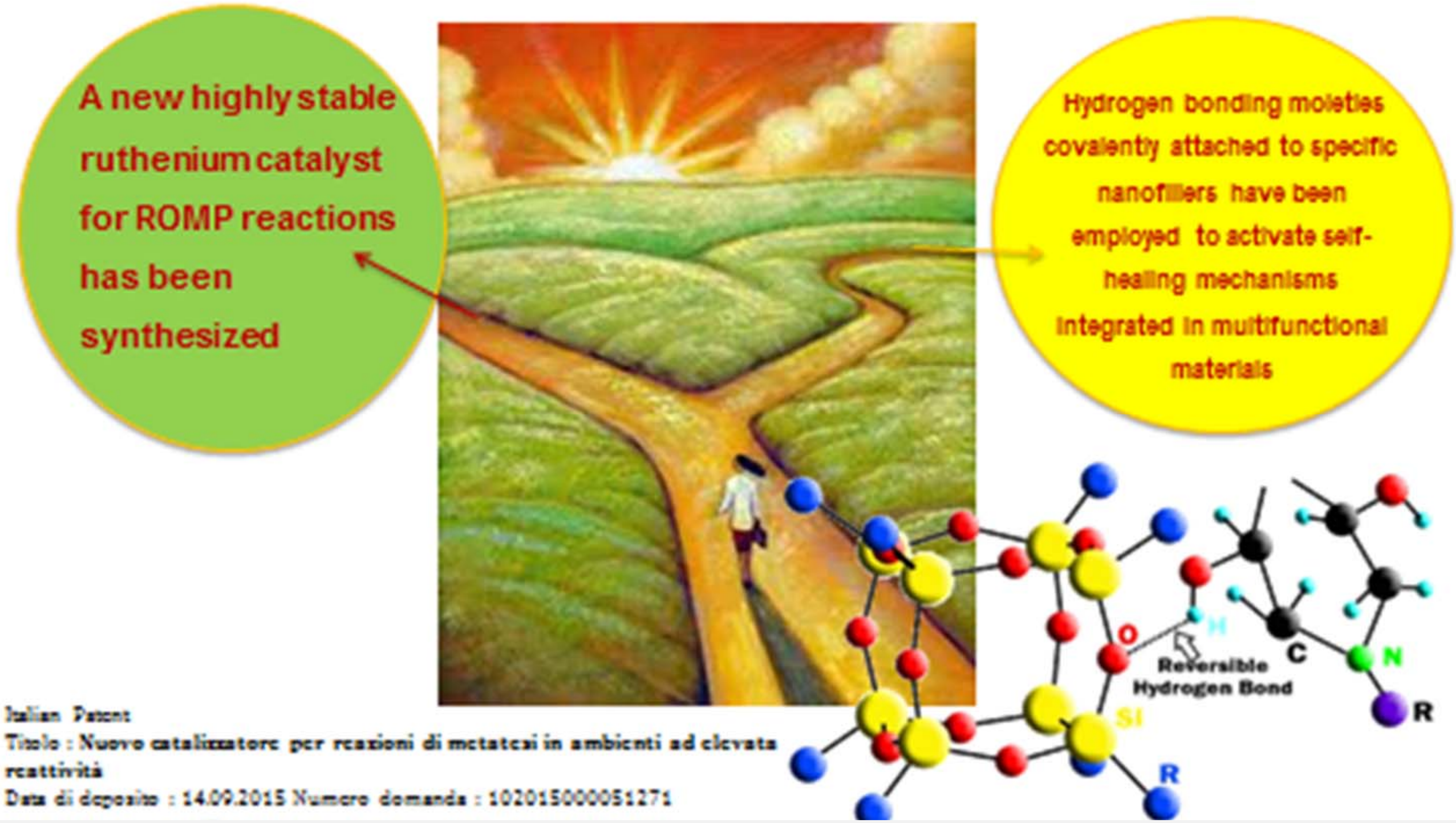


Figure 19: The main results on the self-healing functionalities

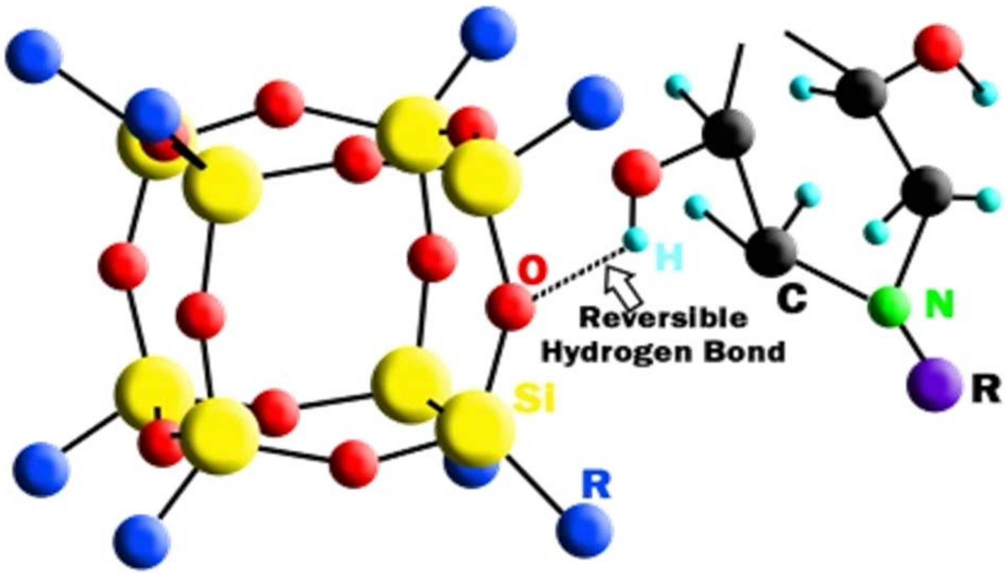


Figure 20. Attractive reversible Hydrogen bonding forces between the nanocages of POSS and chemical groups of the epoxy precursors.

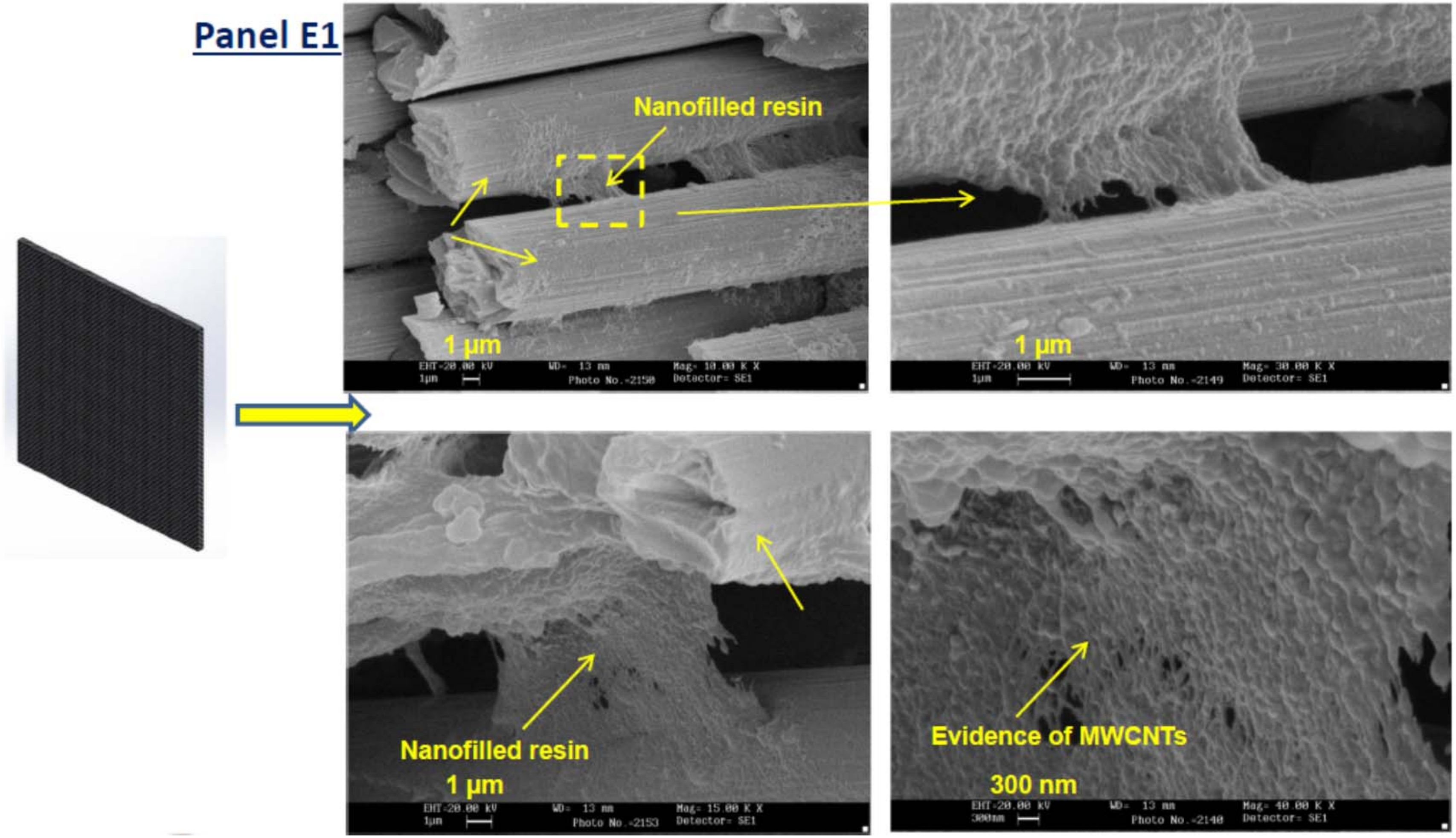
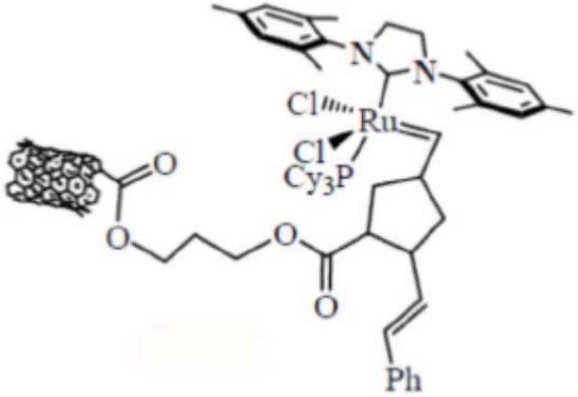
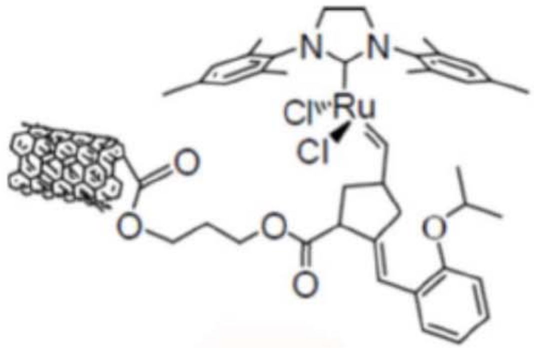


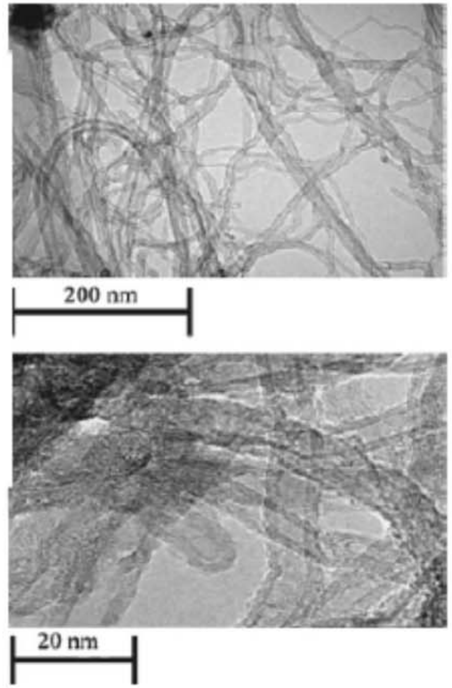
Figure 21: CFRPs manufactured using the developed multifunctional resin.



Carbon nanotube functionalized with Grubbs catalyst 2nd generation (MWCNT-G2$_{pr}$).



Carbon nanotube functionalized with Hoveyda-Grubbs catalyst 2nd generation (HG2).



High resolution transmission electron microscope images of the MWCNTs

Figure 22: Scheme of the Grubbs catalyst 2nd generation (G2) and Hoveyda-Grubbs catalyst 2nd generation (HG2) covalently bonded on the wall of MWCNTs.

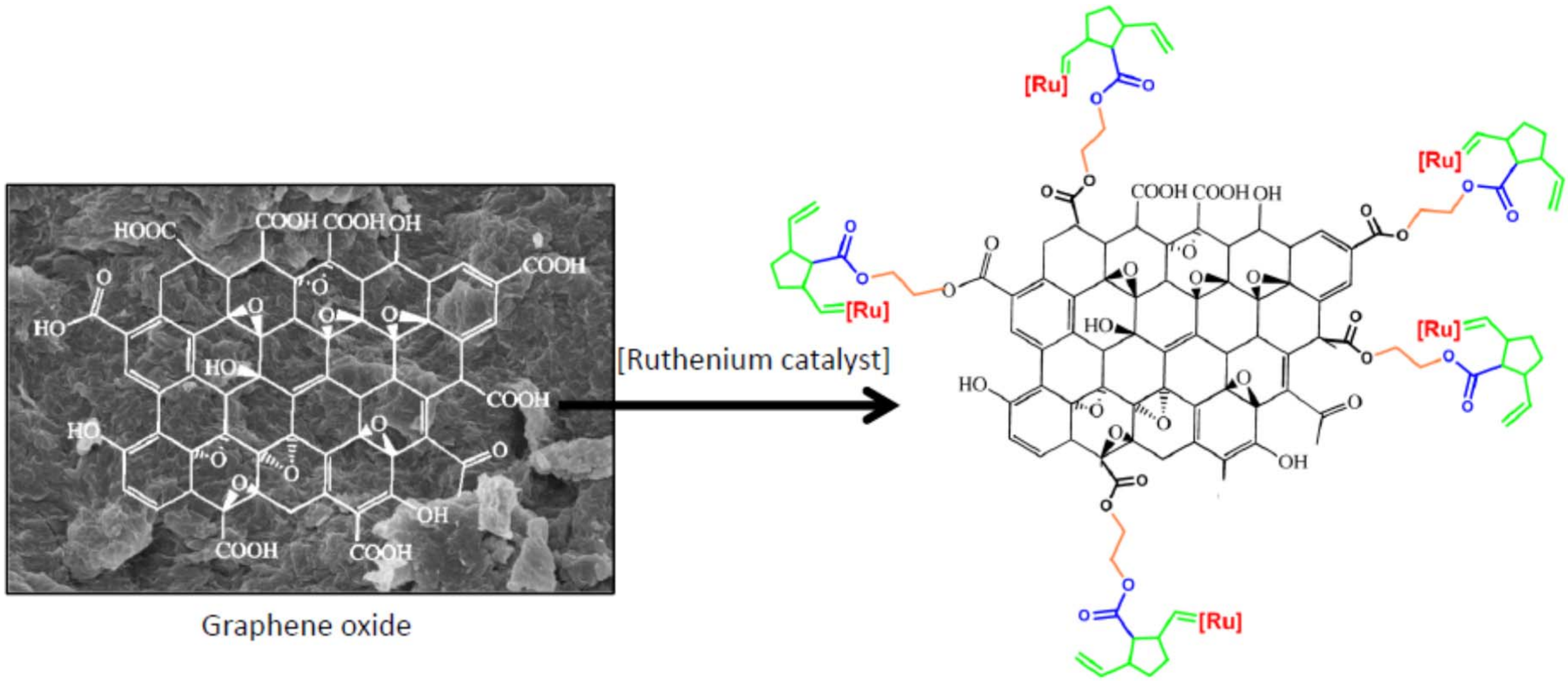


Figure 23: ***Functionalization of graphene oxide with Ruthenium catalyst***

Table 1: List of Panels manufactured with formulation 1

Label	Composition		Manufactured via
	Matrix	Fillers wt/wt %	
First period			
Sample A	T25BD-90DDS	No Filler	LIQUID INFUSION
Sample B	T20BD	No Filler	LIQUID INFUSION
Sample C	T20BD	0.5% CNT	LIQUID INFUSION
Sample D	T20BD	0.5% CNT	BULK INFUSION
Sample E1	T25BD	0.5% CNT 5% GPOSS	BULK INFUSION (7 plies)
Sample E2	T25BD	0.5% CNT 5% GPOSS	BULK INFUSION (14 plies)
Sample F	T25BD	No Filler	BULK INFUSION (14 plies)
Second period			
Sample E2	T25BD	0.5% CNT 5% GPOSS	BULK INFUSION (14 plies)
Sample E3 (5C)	T25BD	0.5% CNT 5% GPOSS	BULK INFUSION (24 plies) Con foglio di PEEK 10 micron per DCB specimens
Sample F2 (4B)	T25BD	No filler	BULK INFUSION (24 plies) Con foglio di PEEK 10 micron per DCB specimens
Sample E4	T25BD	0.5% CNT 5% GPOSS	BULK INFUSION (24 plies)
Sample E4 (6C)	T25BD	0.5% CNT 5% GPOSS	BULK INFUSION (24 plies)
Sample F3 (5B)	T25BD (Master batch nano4)	No filler	BULK INFUSION (24 plies)
Sample LS1	T25BD	0.5% CNT 5% GPOSS+Flame retardant	BULK INFUSION (8 plies)
Sample G	80%w DGEBA (Epon828) + 20%w BDE) + 10% w of (Epon+BDE) Ankamine 54	No filler	BULK INFUSION (24 plies)
Sample LS2	T25BD	0.5% CNT 5% GPOSS+Flame retardant	BULK INFUSION (8 plies)

Sample E5	***T25BD***	***0.5% CNT*** ***5% GPOSS***	***BULK INFUSION (24 plies) Con foglio di PEEK 10 micron per DCB specimens***

Figure 24: Simple Panels

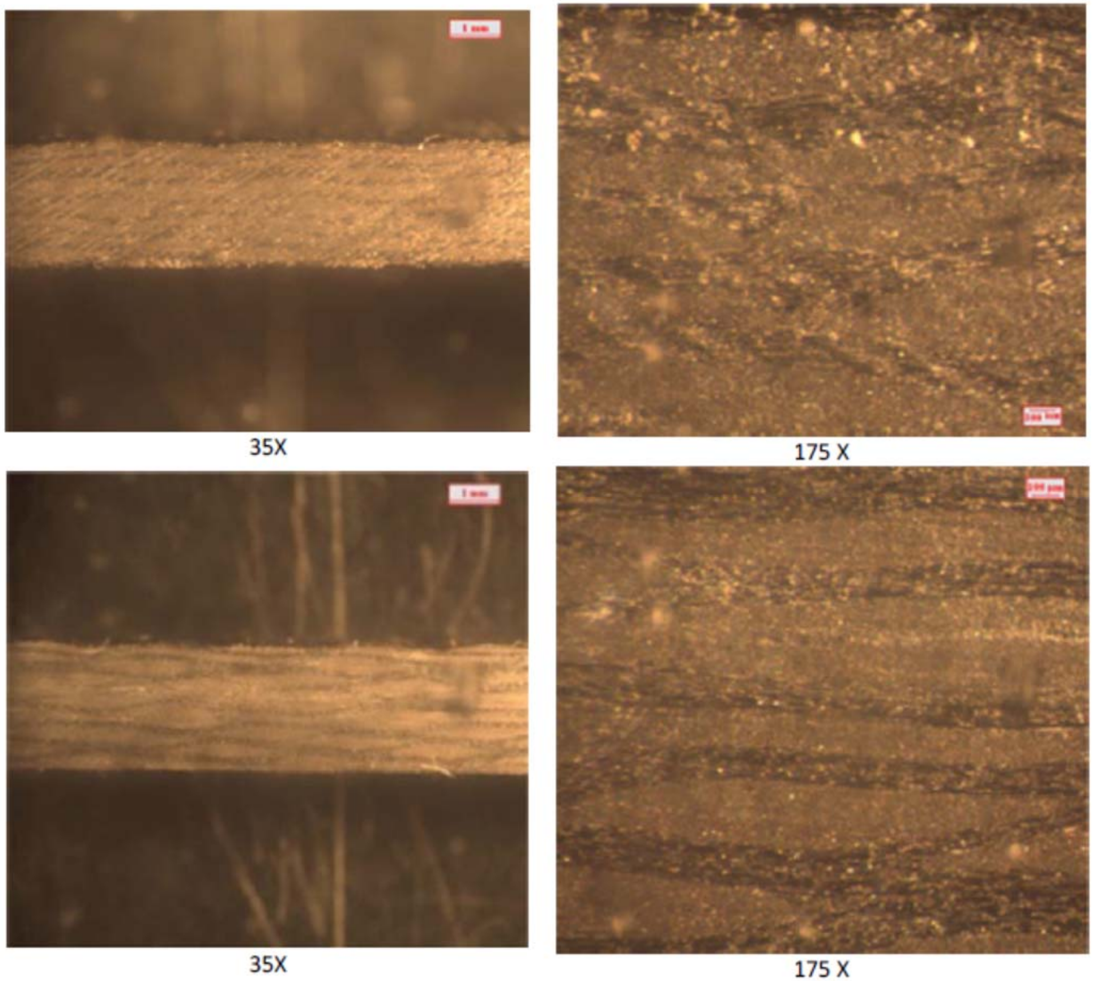


Figure 25: Microscope Inspections

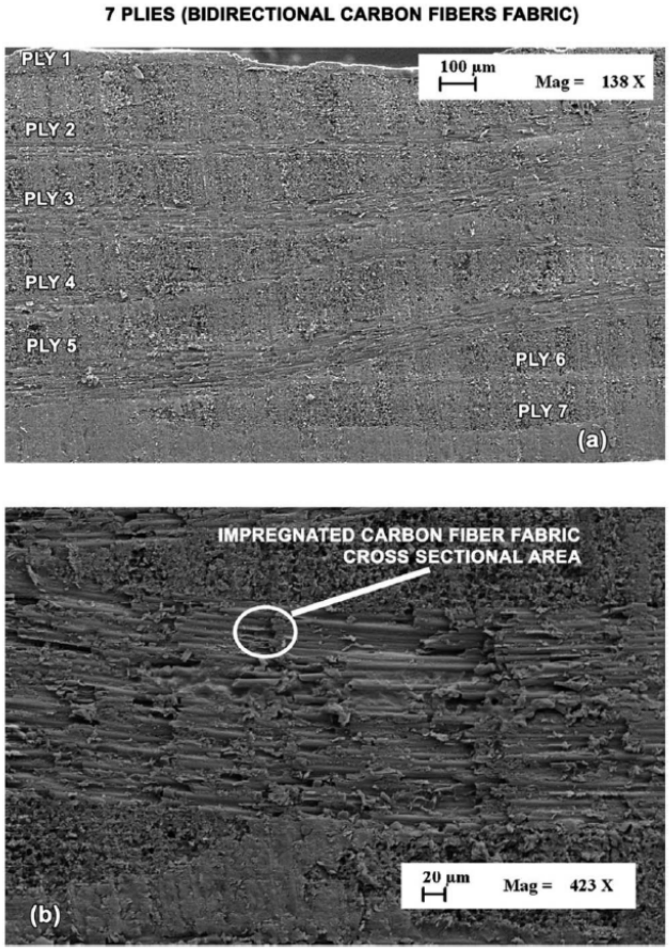


Figure 26: SEM images, at two different magnification, of the cross sectional area of the manufactured panels (7 plies)

Figure 27: Preliminary panels with microcapsules

Figure 28: Panel with microcapsules and reference panels

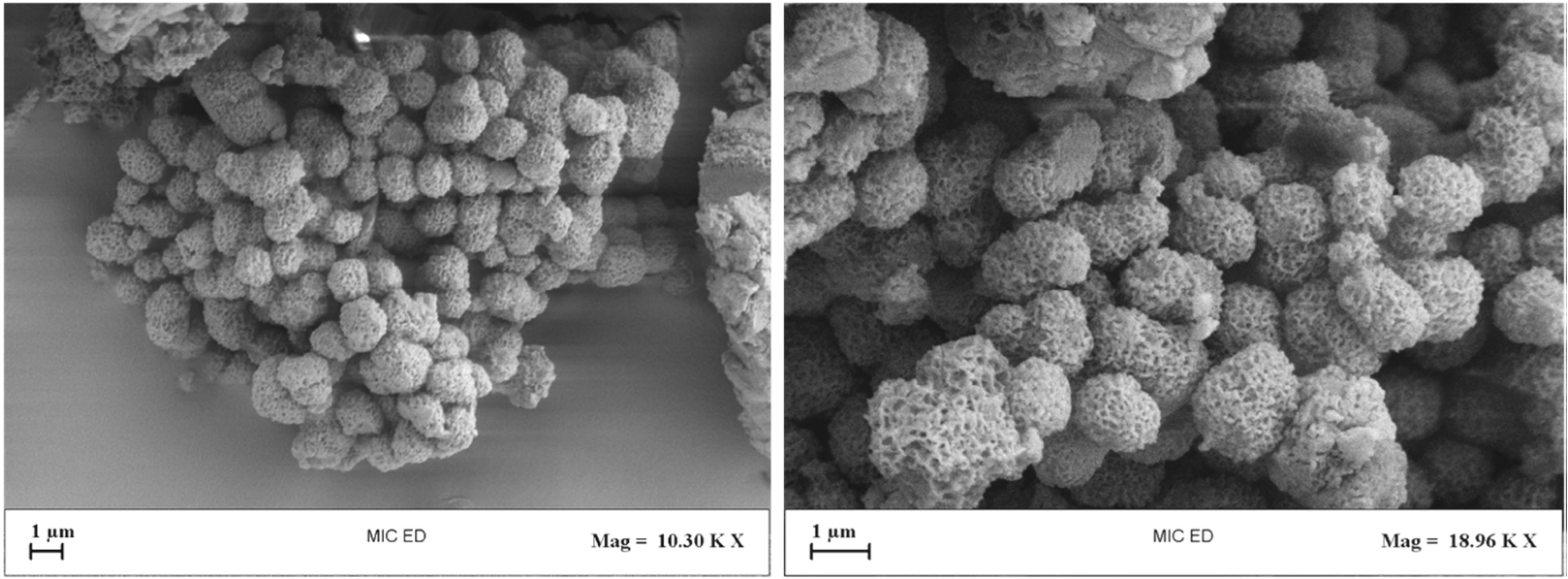


Figure 29: FESEM images of the ENB/DCPD microcapsules used to manufacture panels.

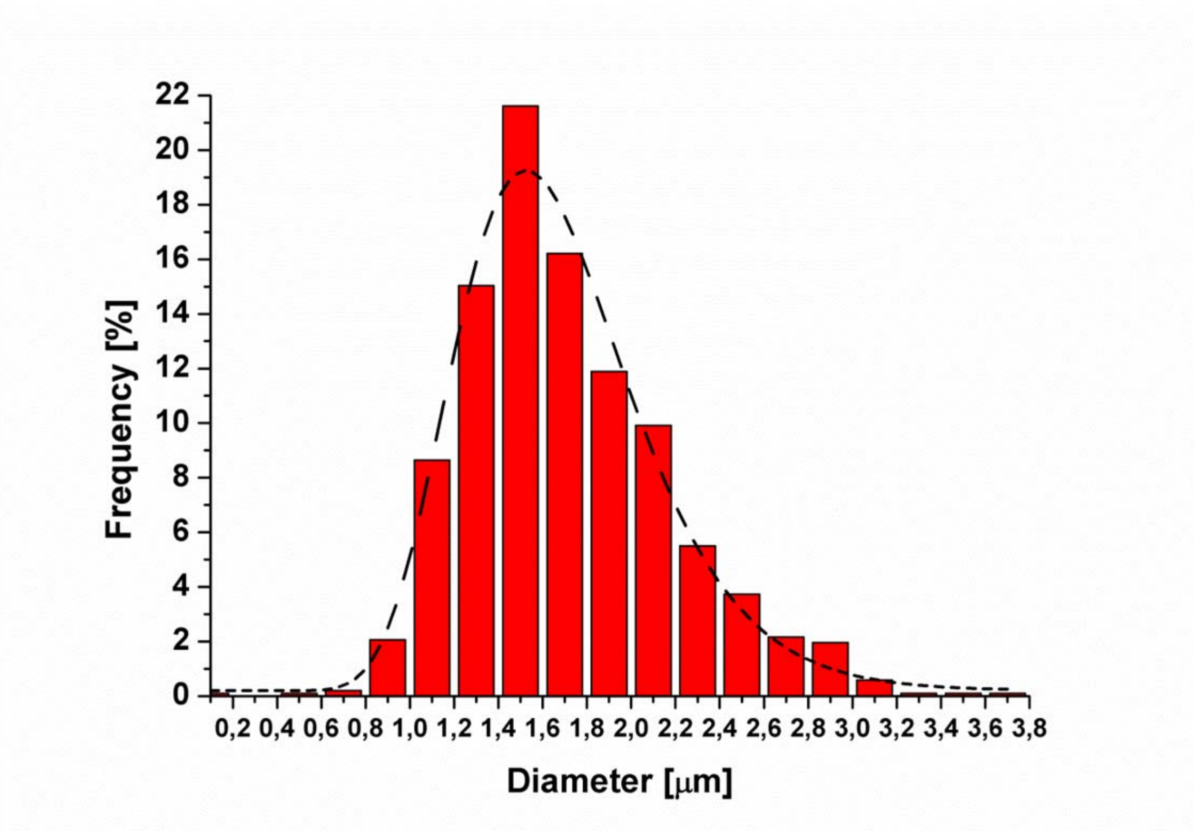


Figure 30: Histogram of the microcapsule diameter

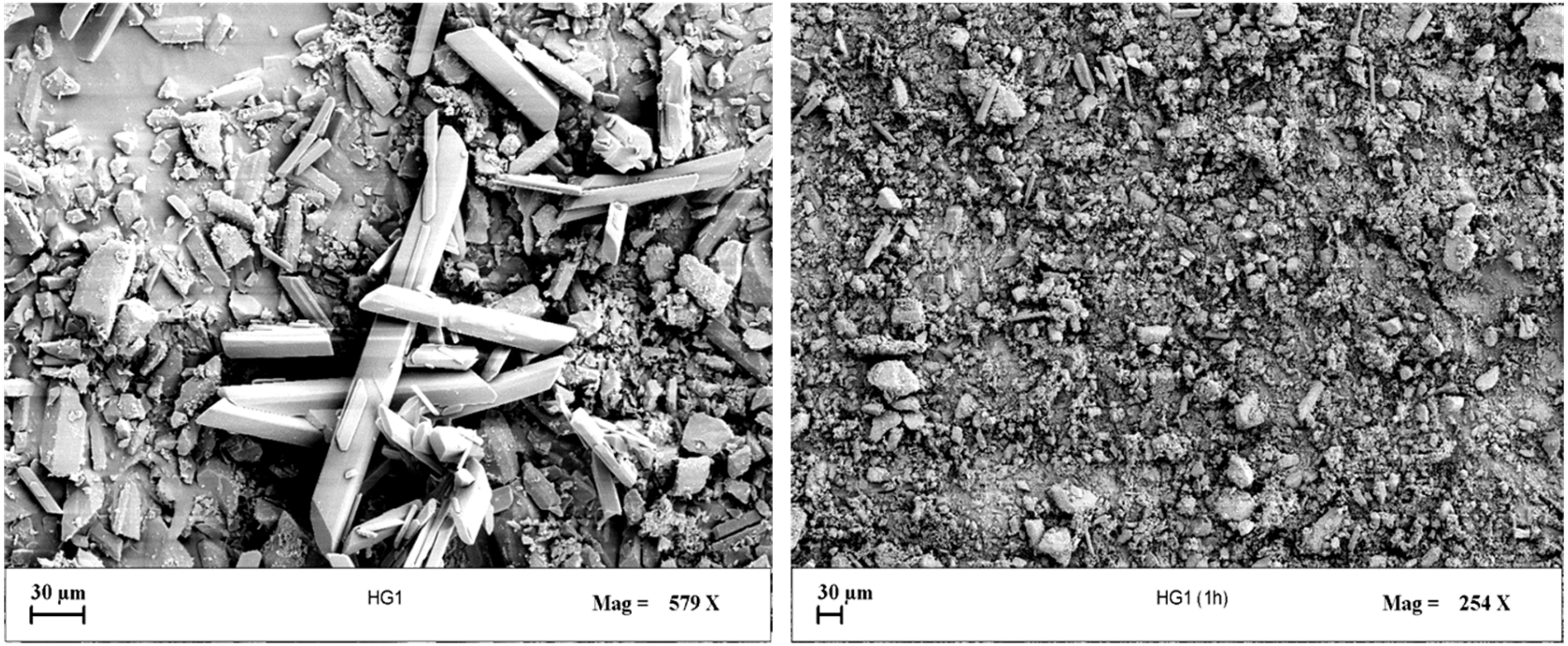


Figure 31: FESEM images of HG1 catalyst before (see on the left) and after (see on the right) pulverization

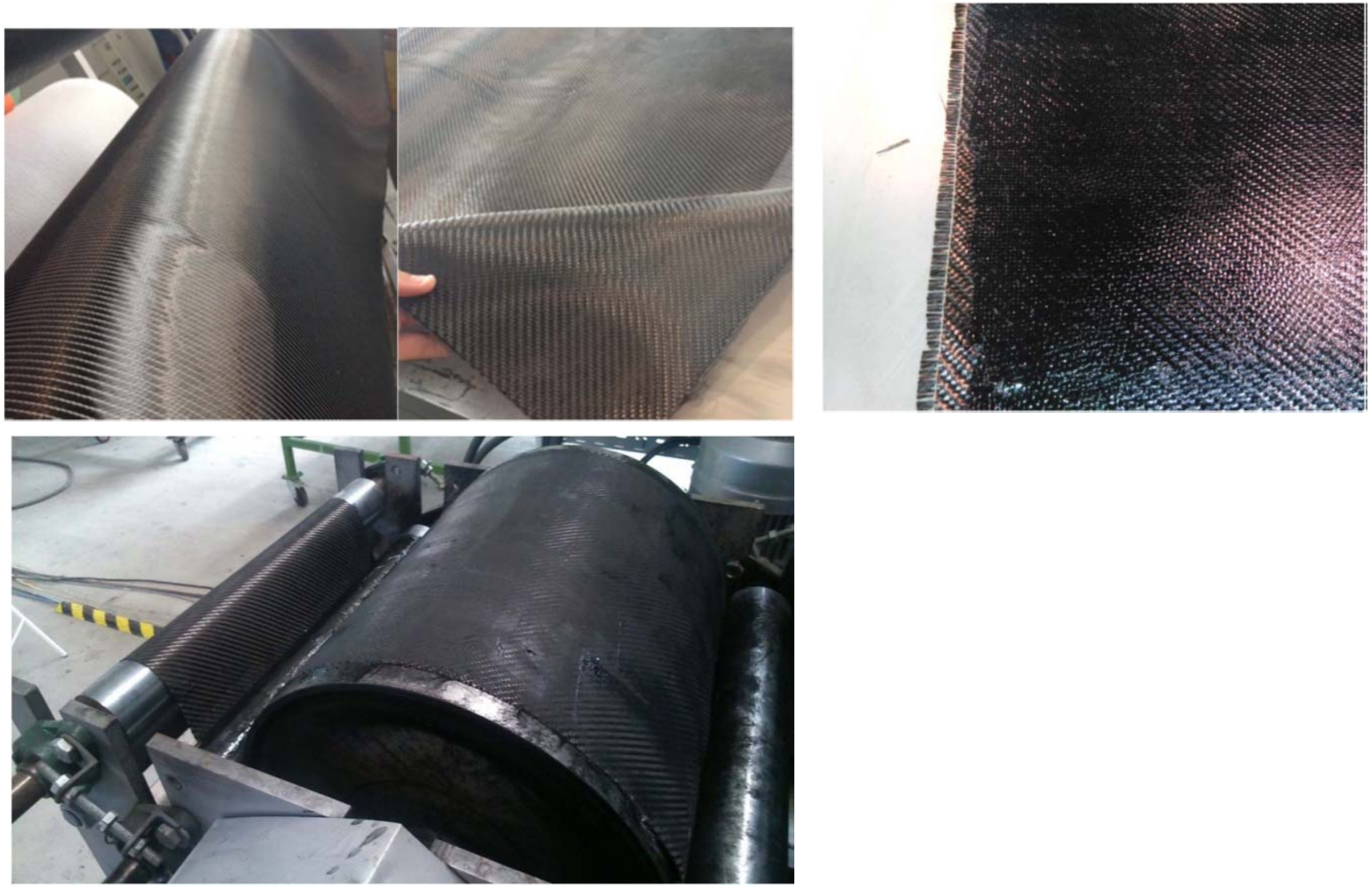


Figure 32: Phases of the manufacturing of prepreg with nanocharged resin

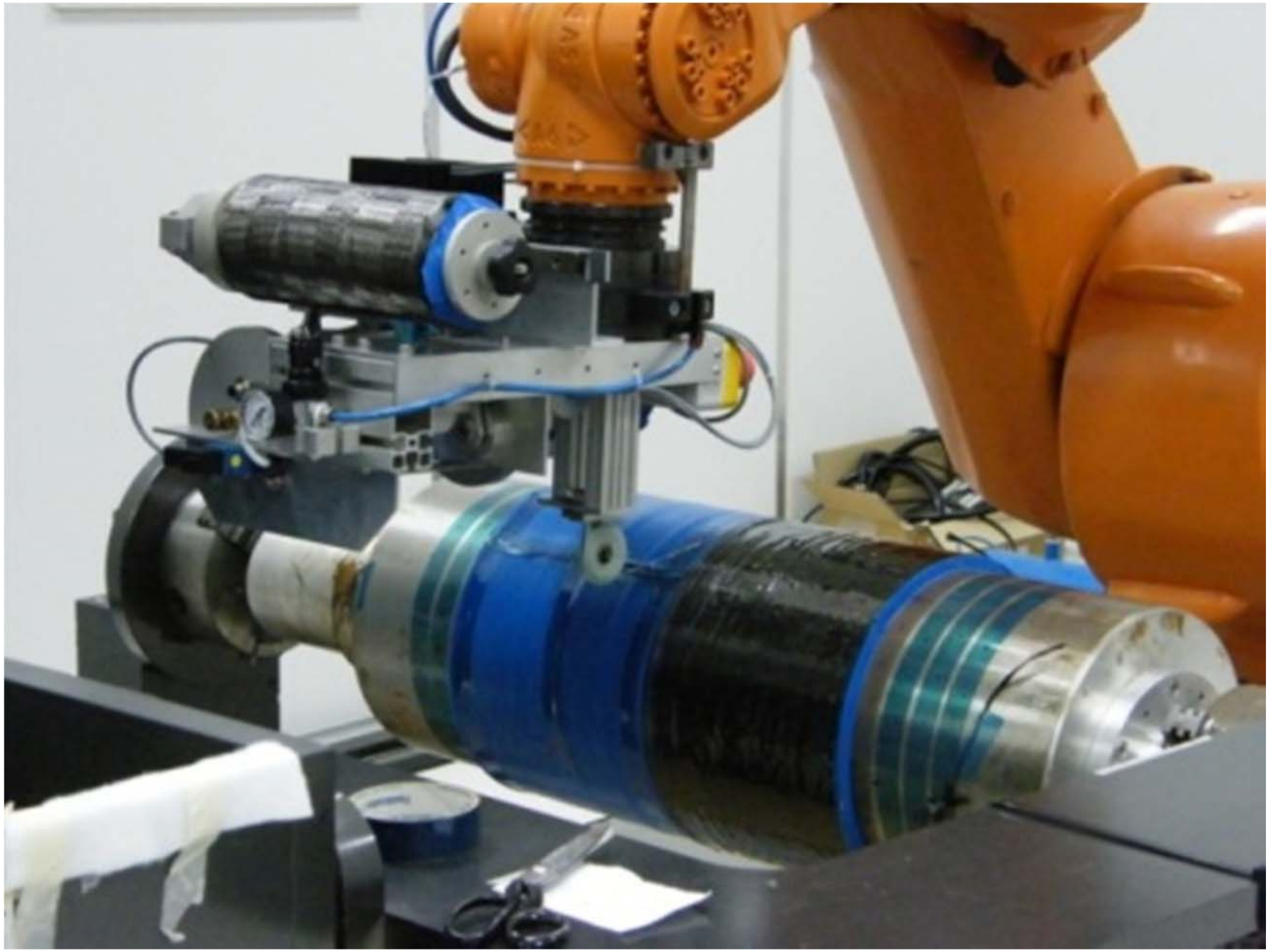


Figure 33: Automated head for wet winding

Figure 34: Wounded cylinder and rings

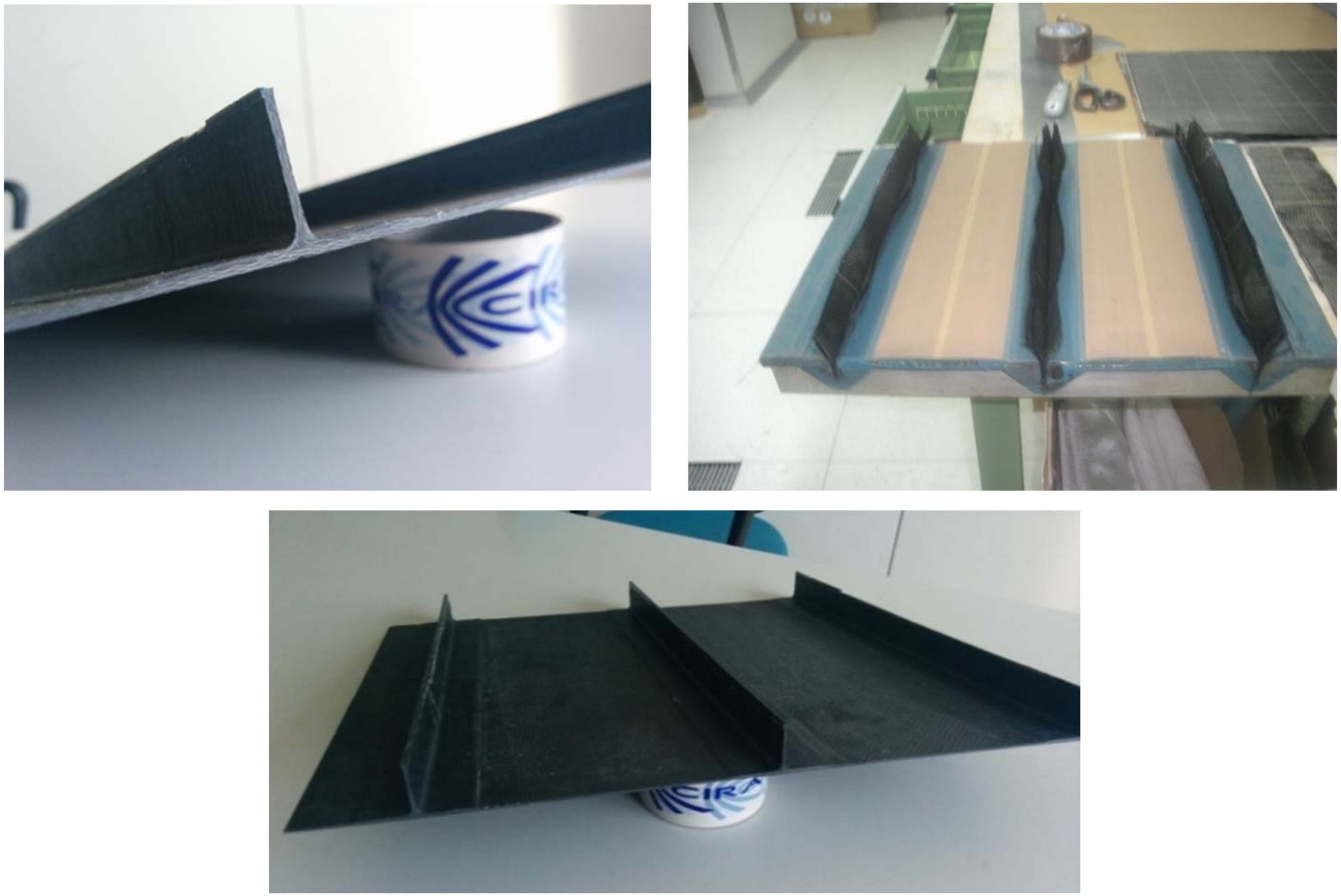


Figure 35: Demonstrator Panel produced by infusio

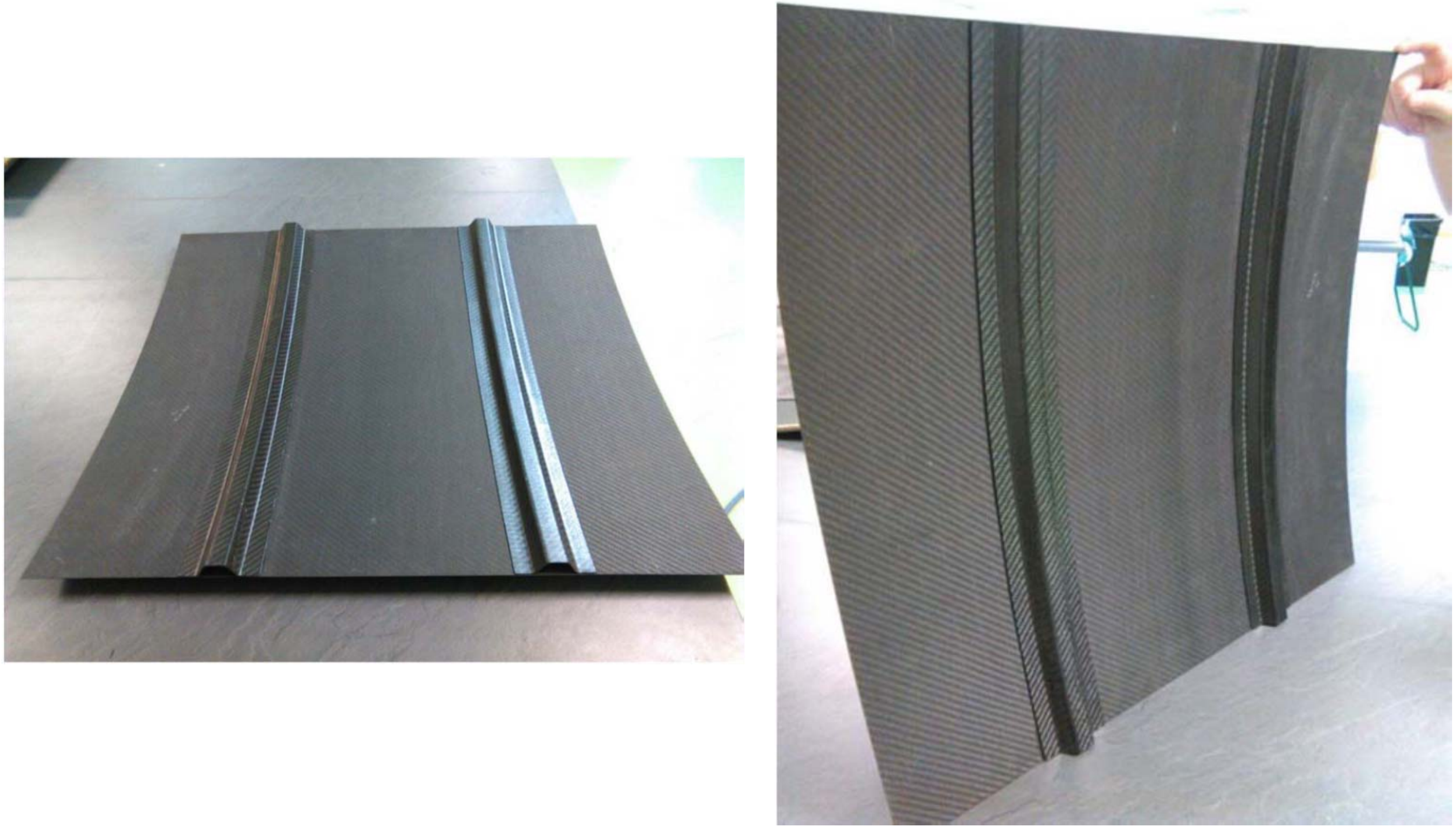


Figure 36: Demonstrator Panel by prepregging.

Figures for **Appendix in description of the project context and the main objectives**

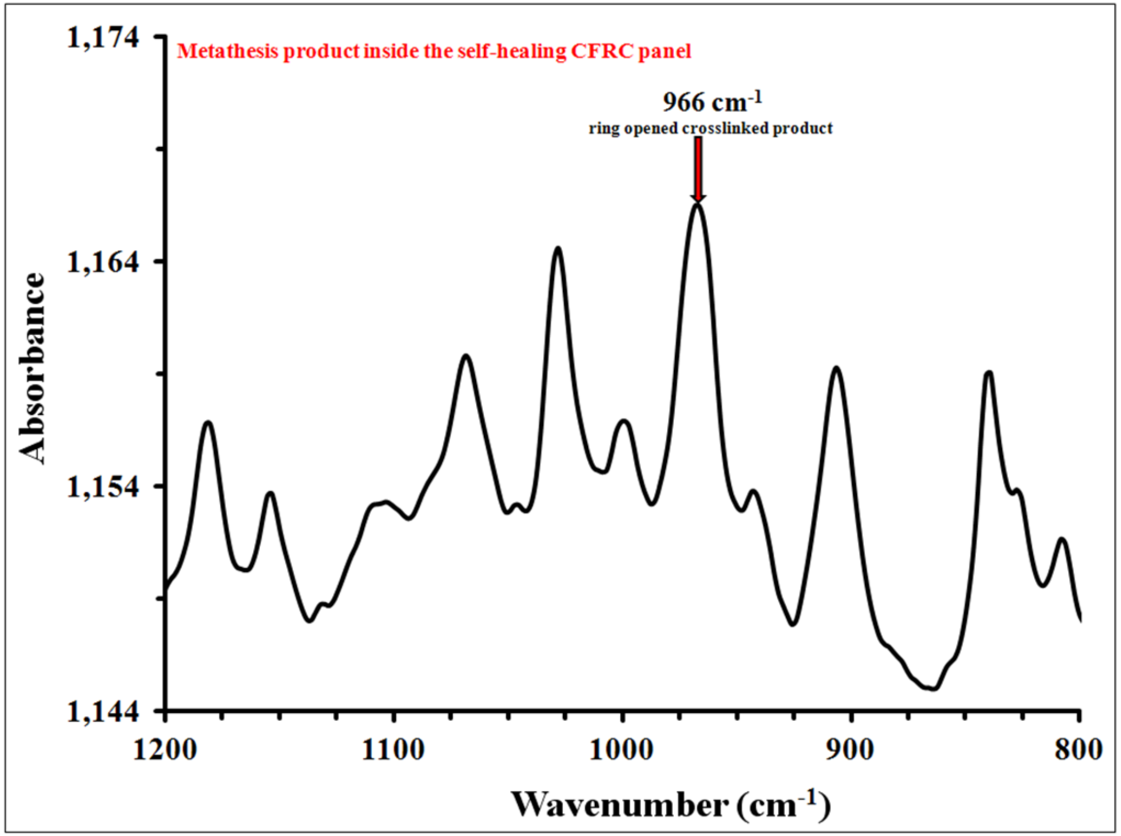


Figure 37. FTIR spectrum of self-healing panel (SH1) powder treated with ENB. The highlighted peak at 966 cm^{-1} is characteristic of ring-opened poly(ENB)

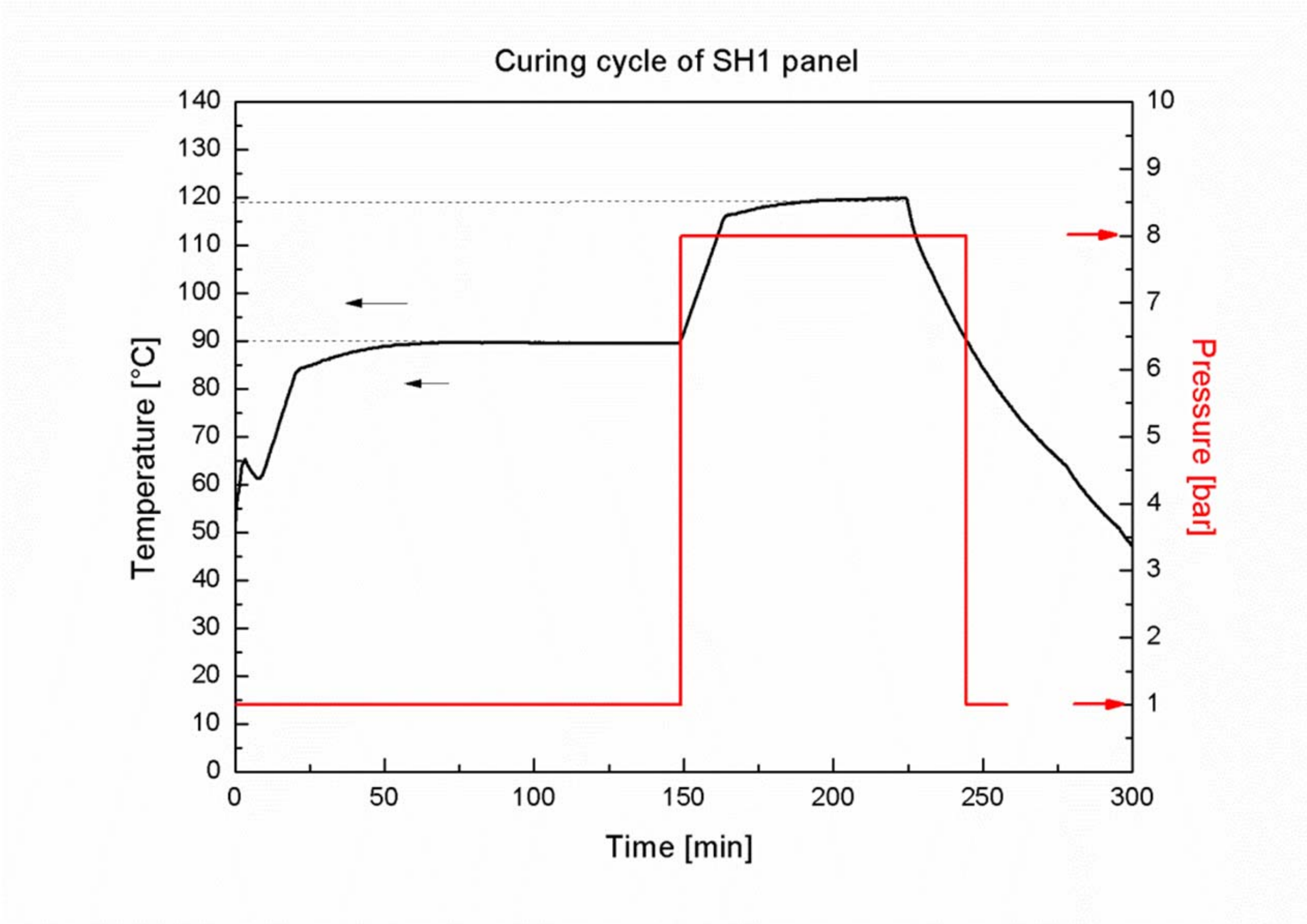


Figure 38. Curing cycle and pressure for the impregnation process

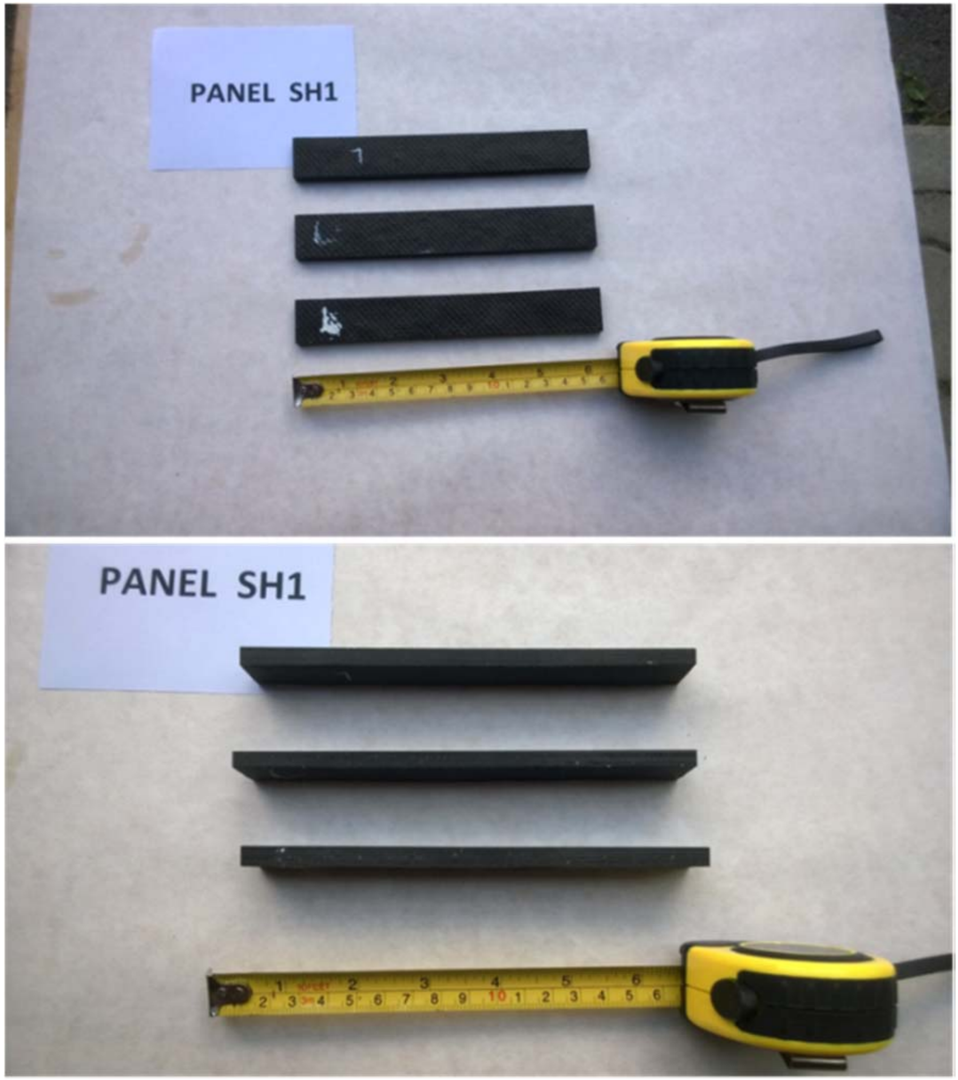


Figure 39. Coupons extracted from self-healing panels

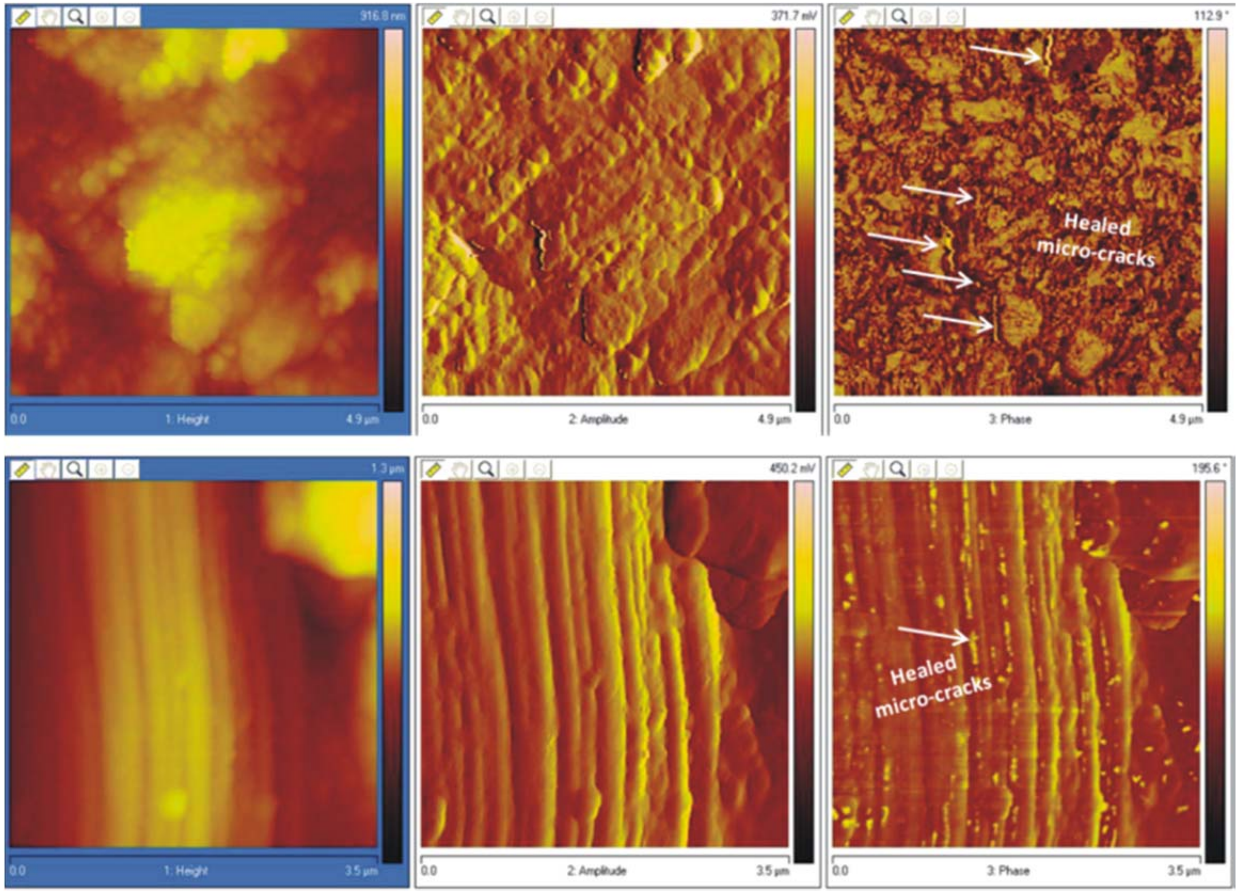


Figure 40. AFM images of fracture surface of the self-healing panel with healed micro-cracks

Figures for **description of the potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and the exploitation of results.**

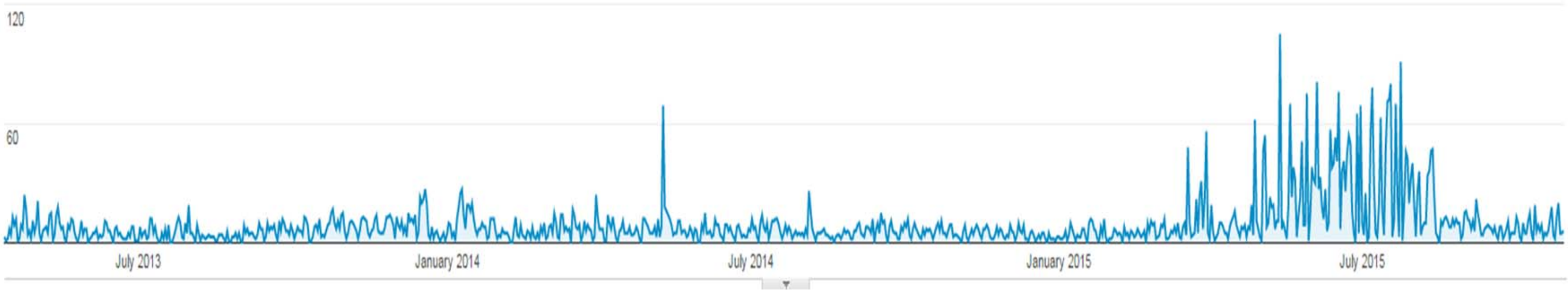


Figure 41: IASS website users, April 2013-October 2015

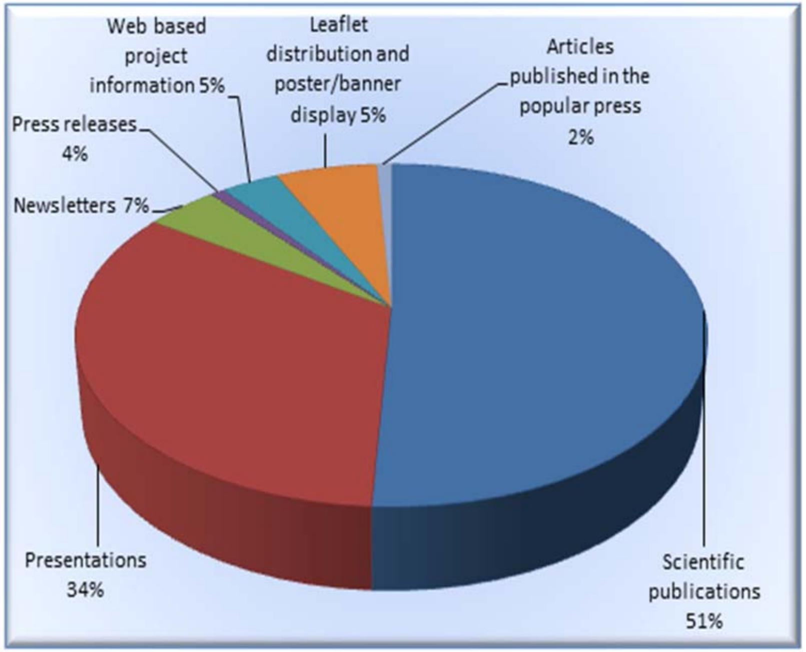


Figure 42: IASS related performed Dissemination Activities

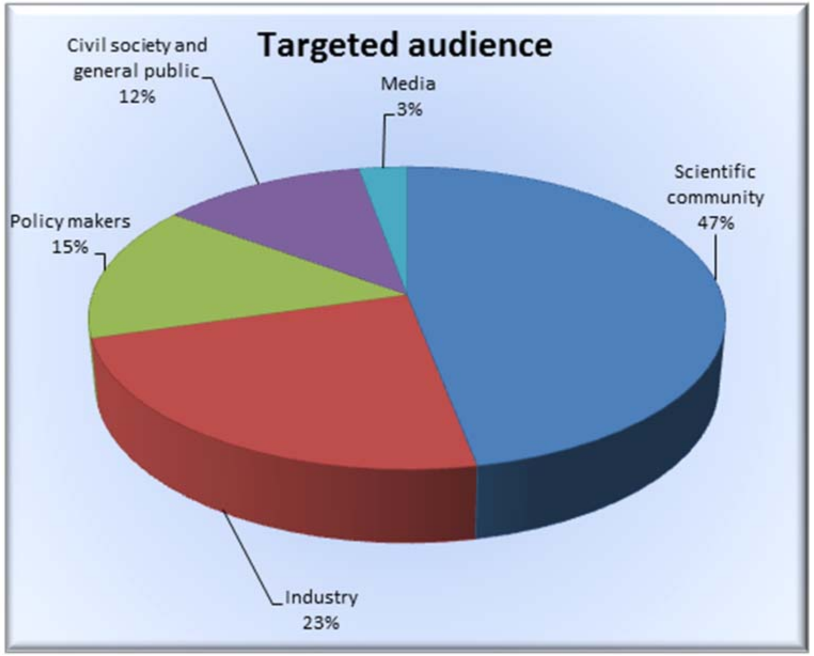


Figure 43: Target groups reached through the dissemination activities realized during the project's second period

Figure 44: Geographic coverage of the performed dissemination activities

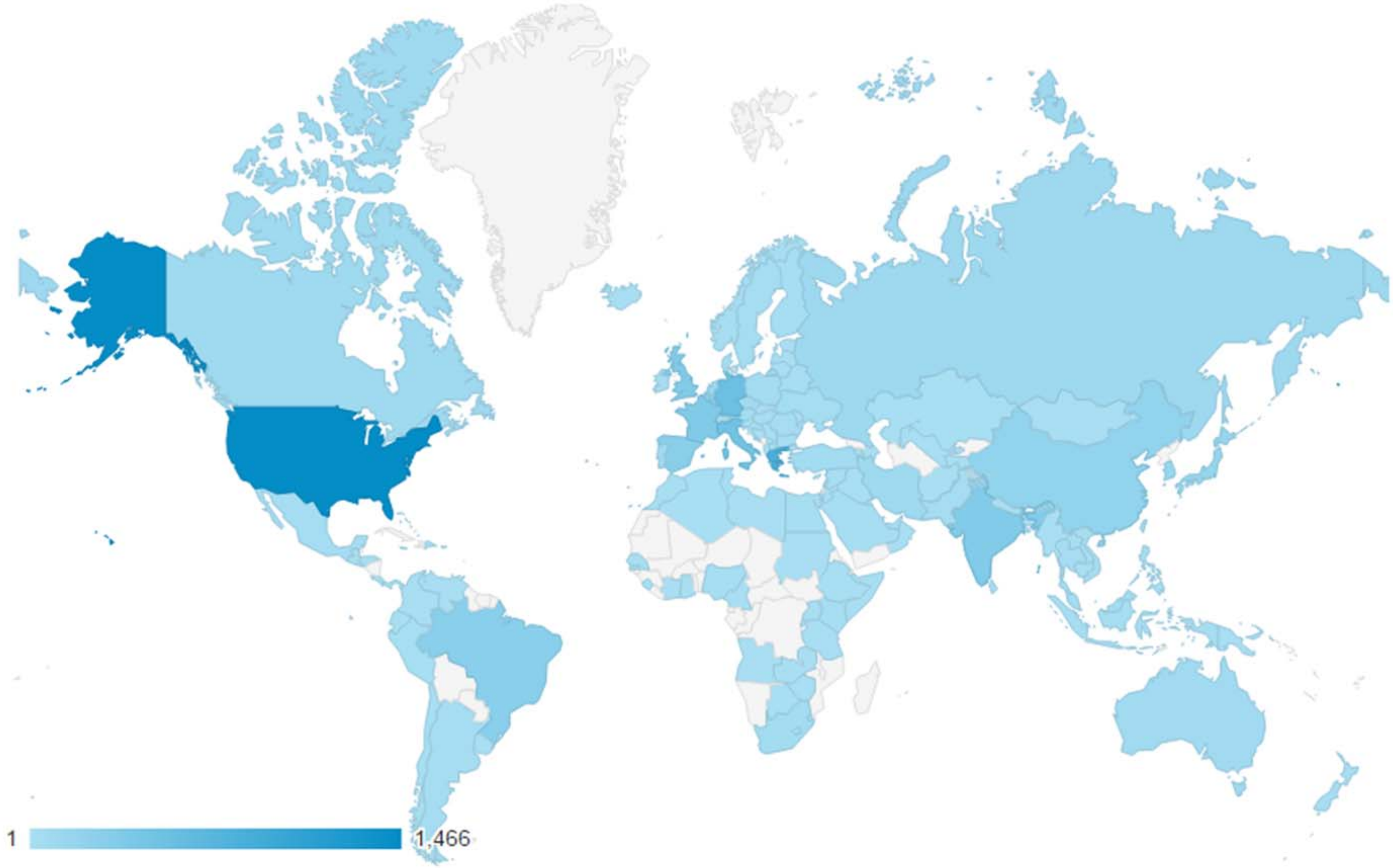


Figure 45: Geographic coverage of the IASS website visitors