

NEWSPEC GA n. 604168 – FINAL REPORT – Figures and Tables

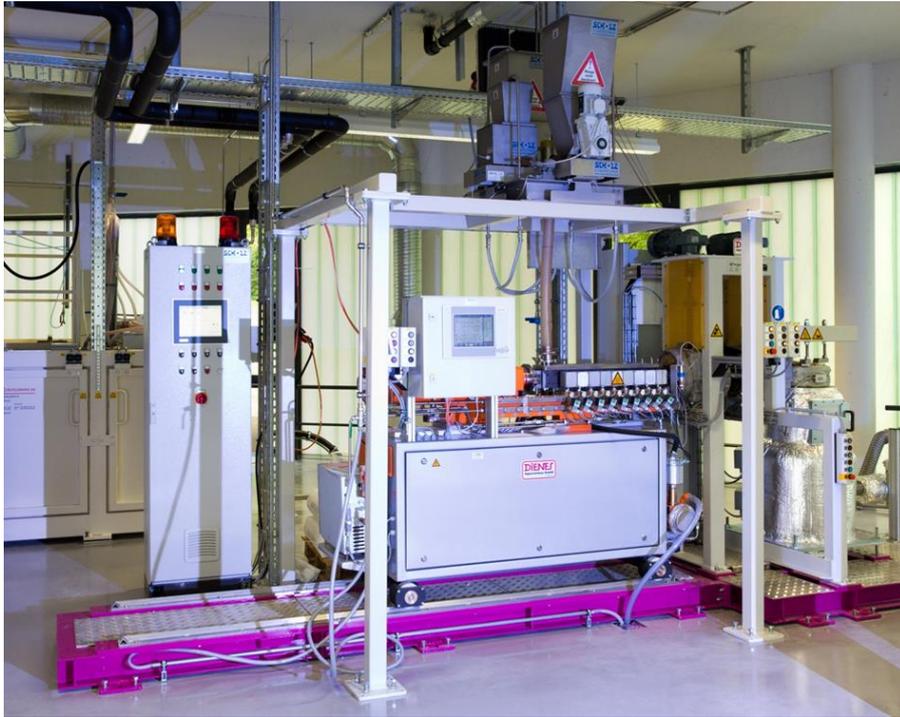


Figure 1 Melt-spinning pilot line for PE-precursor at the HPFC



Figure 2 Joining of PE-precursor fibers in two steps from 0.3K up to 12K precursor fiber



Figure 3 Winding of 12K precursor fiber



Figure 4 Some of the PE precursor spools produced at the HPFC pilot line during NEWSPEC

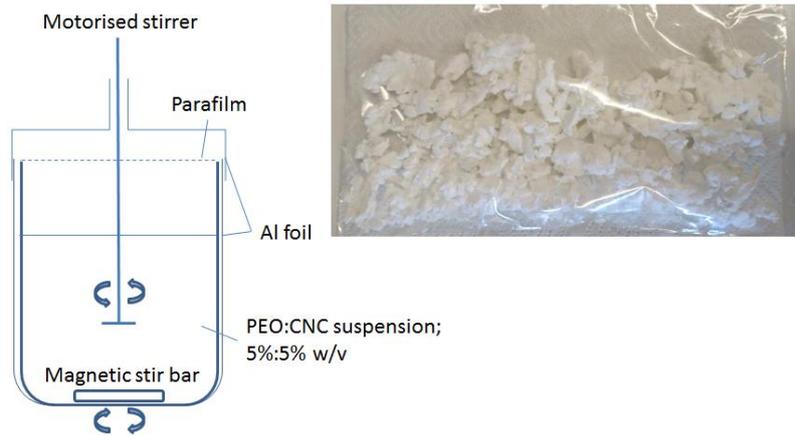


Figure 5 Method for dispersing PEO:CNC into the PE matrix

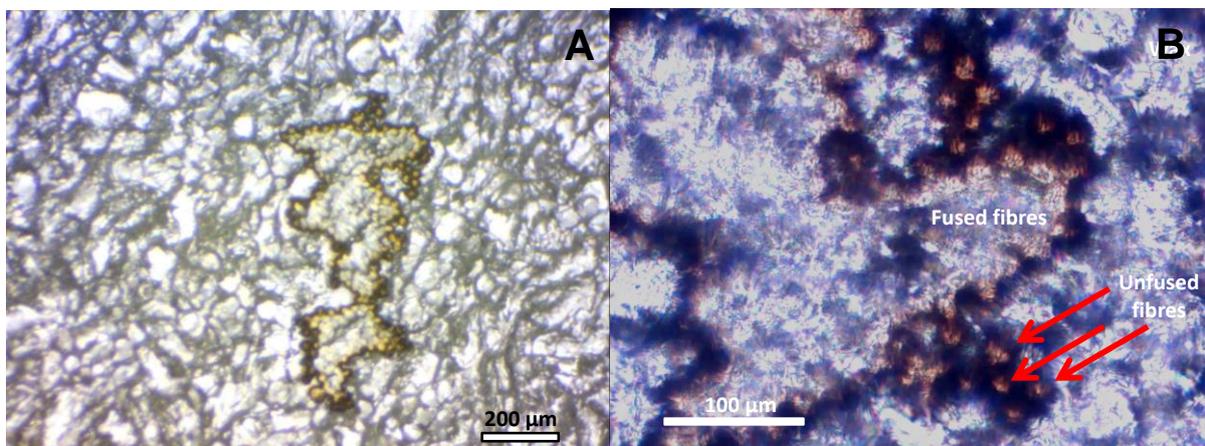


Figure 6 Spool of stabilized PE precursor with CNC additives (top) and light microscopy image of PE1639, 0.125%CNC/PEO fibers after sulfurization - microtome cross section after embedding in paraffin wax (bottom)

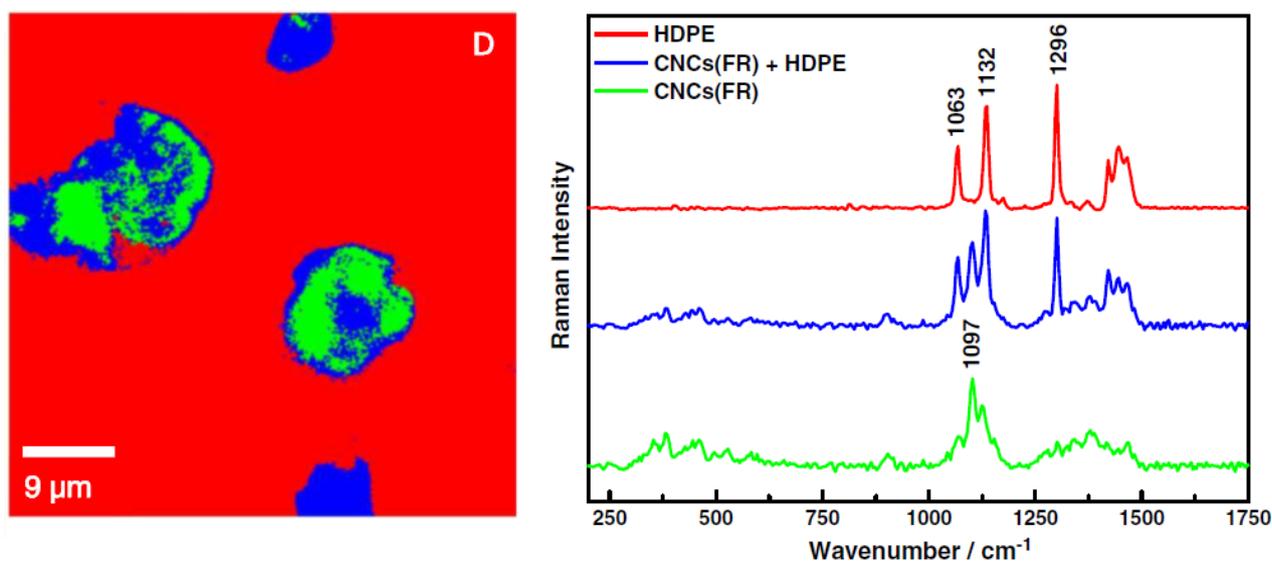


Table 1. Average area fraction of the component of chemical images quantified using Image J software

| Composite | Area fraction | | | Ratio of fraction | |
|--------------------|------------------------|-------------------------|--------------------------|-------------------|-------------|
| | Red (μm ²) | Blue (μm ²) | Green (μm ²) | CNCs/HDPE | Green/Blue |
| 2.5% CNCs(FR)-HDPE | 2194 ± 112 | 238 ± 98 | 35 ± 26 | 0.13 ± 0.06 | 0.16 ± 0.11 |
| 5.0% CNCs(FR)-HDPE | 2216 ± 150 | 164 ± 91 | 60 ± 67 | 0.12 ± 0.08 | 0.25 ± 0.21 |
| 2.5% CNCs(SP)-HDPE | 2265 ± 85 | 105 ± 40 | 97 ± 81 | 0.09 ± 0.04 | 1.27 ± 1.48 |
| 5.0% CNCs(SP)-HDPE | 2220 ± 101 | 148 ± 54 | 100 ± 66 | 0.11 ± 0.05 | 0.72 ± 0.43 |

Red indicates fraction area corresponding to HDPE. Blue indicates fraction area corresponding to CNCs + HDPE; Green indicates fraction area corresponding to CNCs.

Figure 7 (top) Raman maps and intensity plots on HDPE:CNC compounds (bottom) Average area fraction of the component of chemical images.

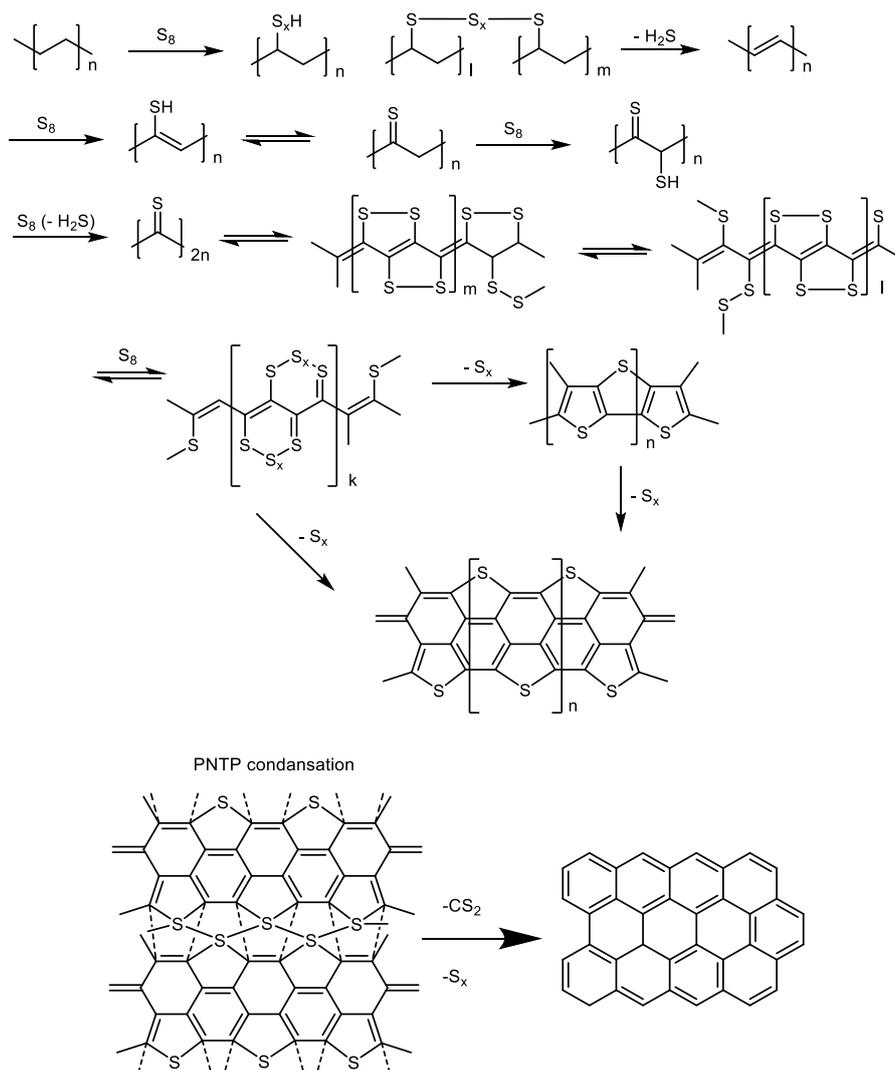


Figure 8: Sulfurization of PE and formation of polynaphthathiothiophene (PNTTP) as precursor of crystalline carbon structure



Figure 9 (left) SULFI equipment, (right) waste-gas treatment plant

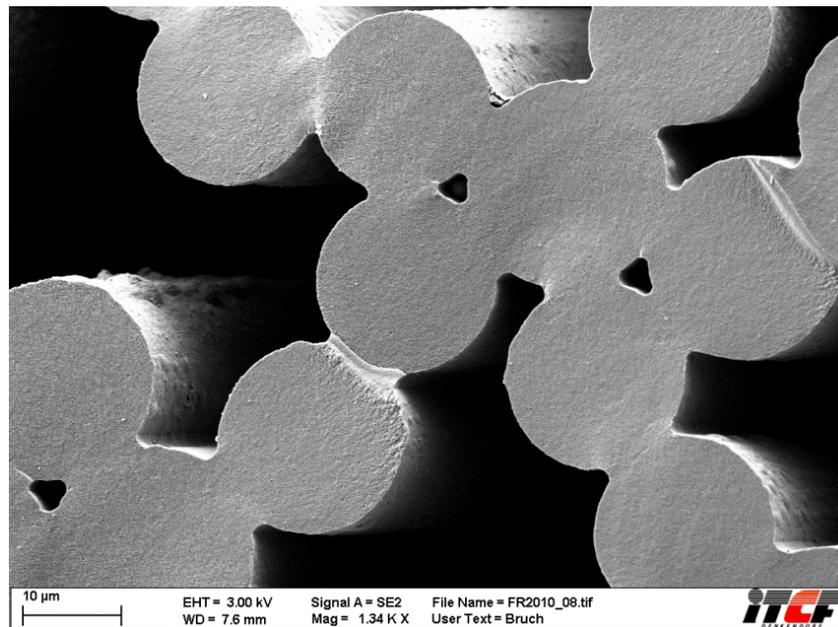


Figure 10 SEM image of carbonized fiber bundles from PE precursor showing the fiber sintering



Figure 11 Mass spools with the produced bicomponent PE fibers

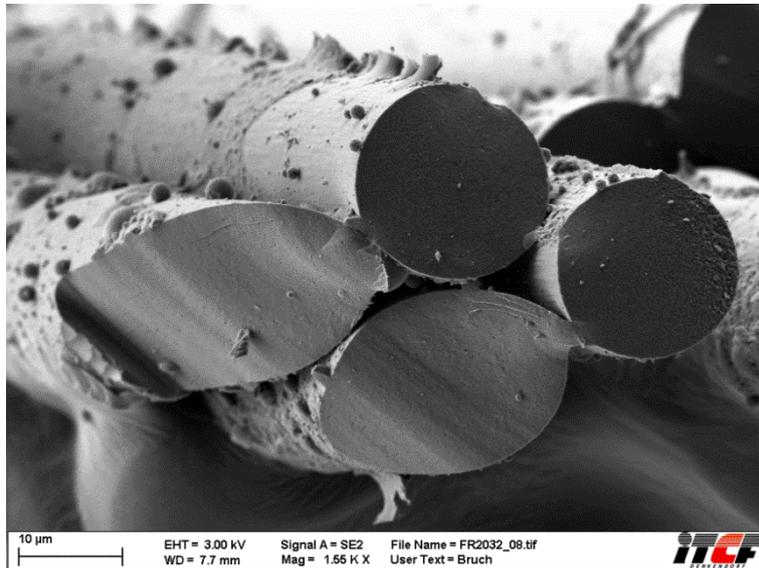


Figure 12 Cross section of the PE fiber (KM0254-01) stabilized at 260°C after the carbonization

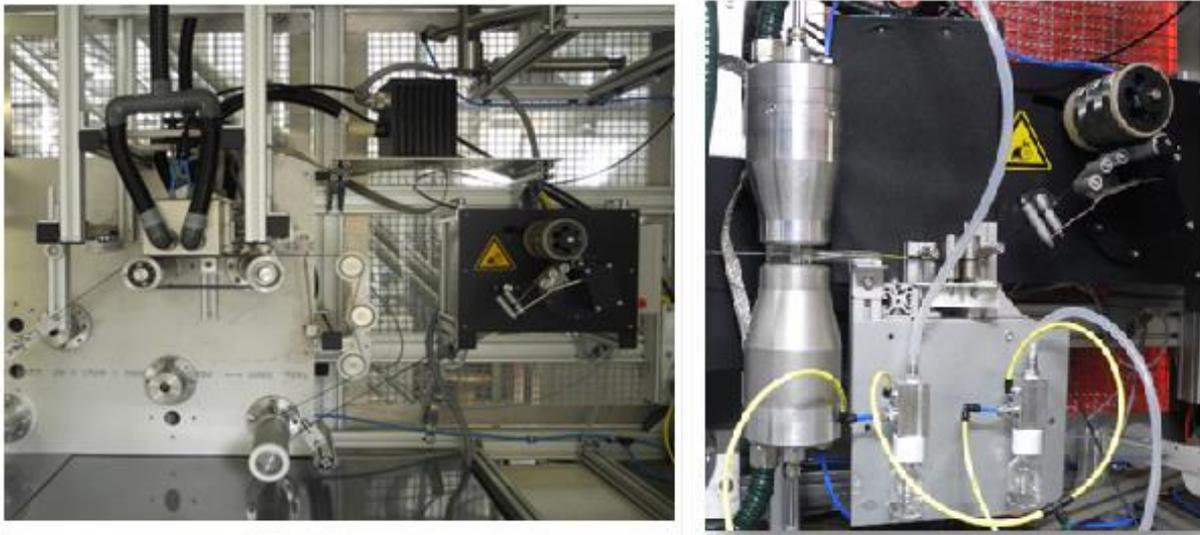


Figure 13 Double-spot pilot prototype for plasma treatment of CFs



Figure 14 Lab scale methodology for RT oxidation of CFs

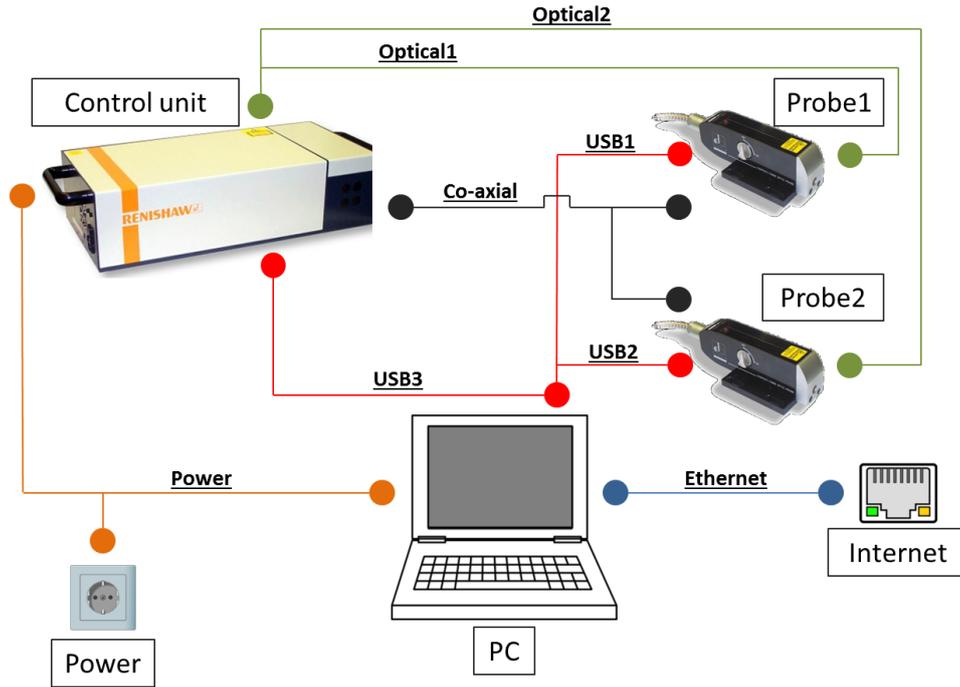


Figure 15 Overview of the Raman system layout

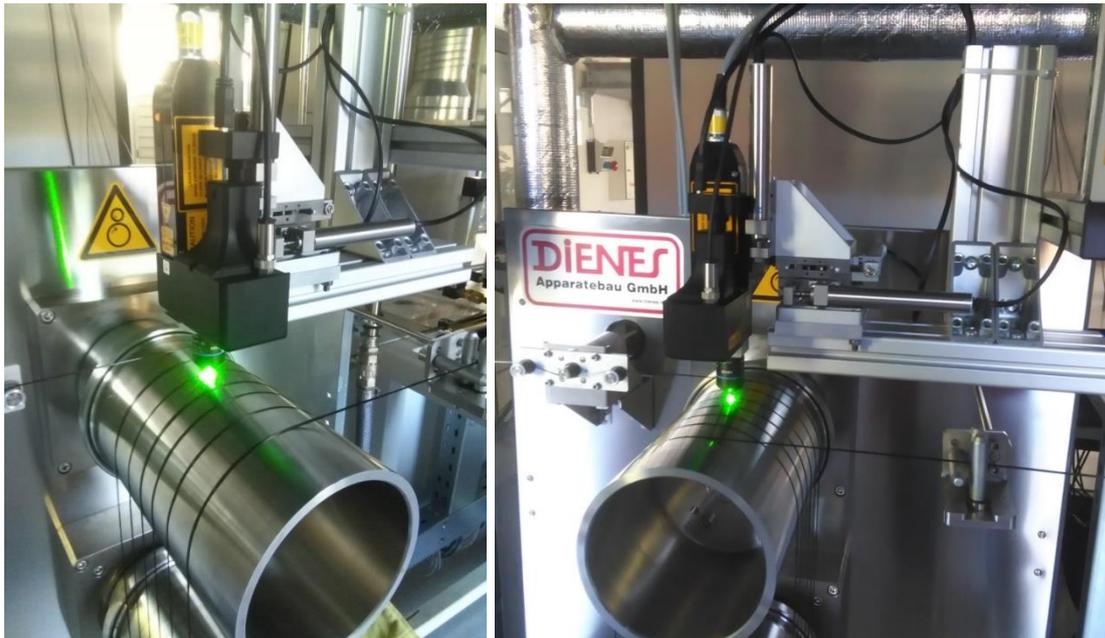


Figure 16 Remote Raman probes in operation at HPFC

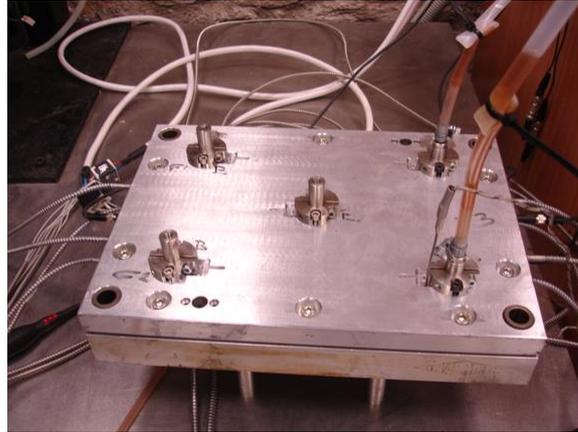


Figure 17 Starting and ending figures of the resin transfer moulding.

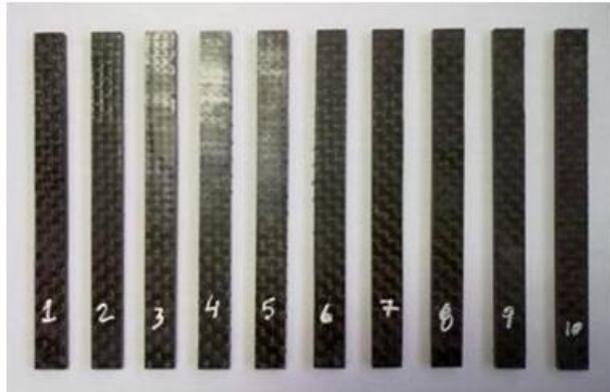
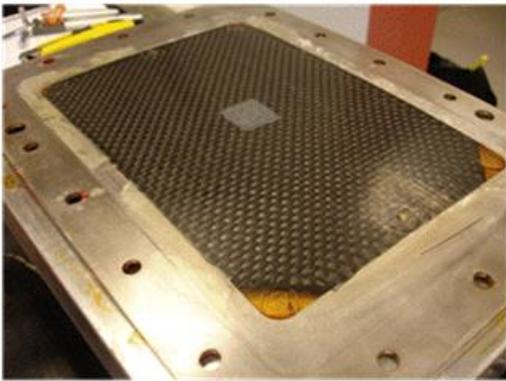


Figure 18 Moulded composite plate and realized specimens for tests

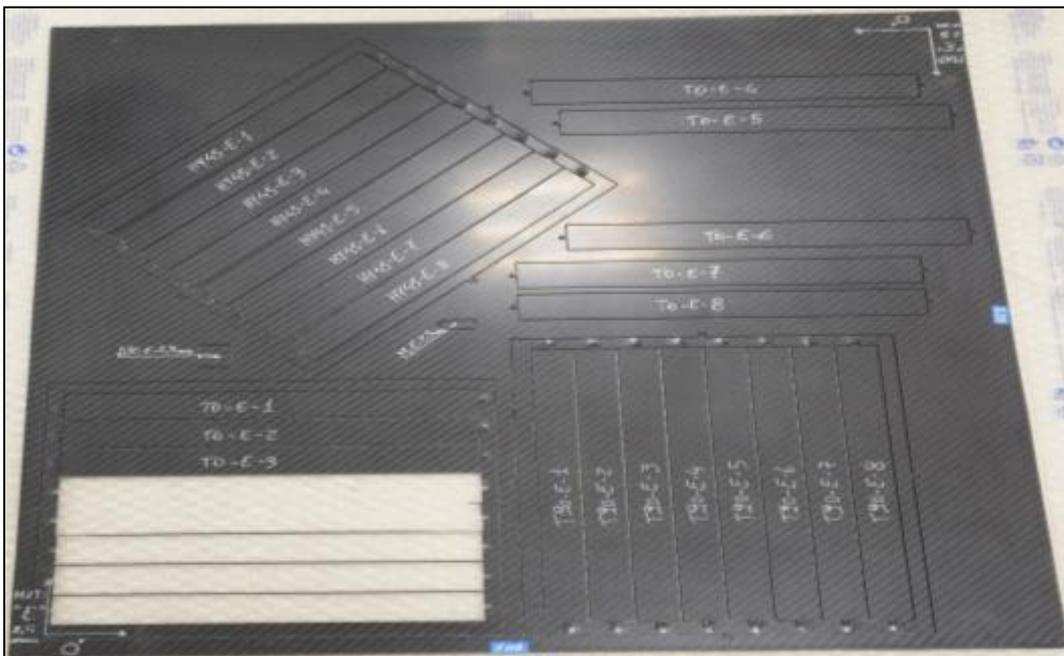


Figure 19 Test specimens obtained by water-jet cutting of 2,5mm plate.

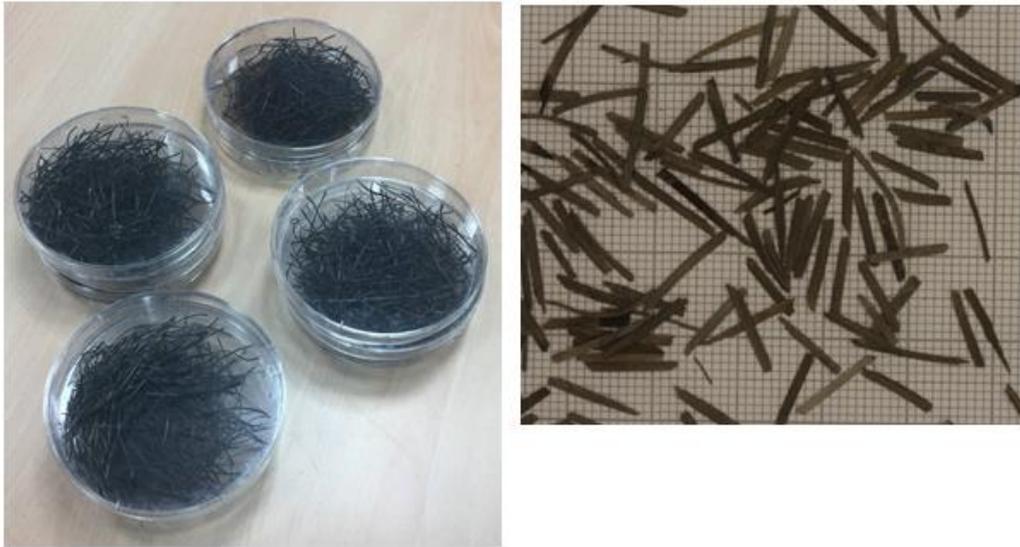


Figure 20 PE-CFs as received from DITF (left), chopped PE-CFs (right)



Figure 21 (upper left) New functionalized CFs (upper right) Produced high pressure natural gas storage vessels and picture of semi-finished demonstrator on the mandrel with winded technological shell (bottom right).

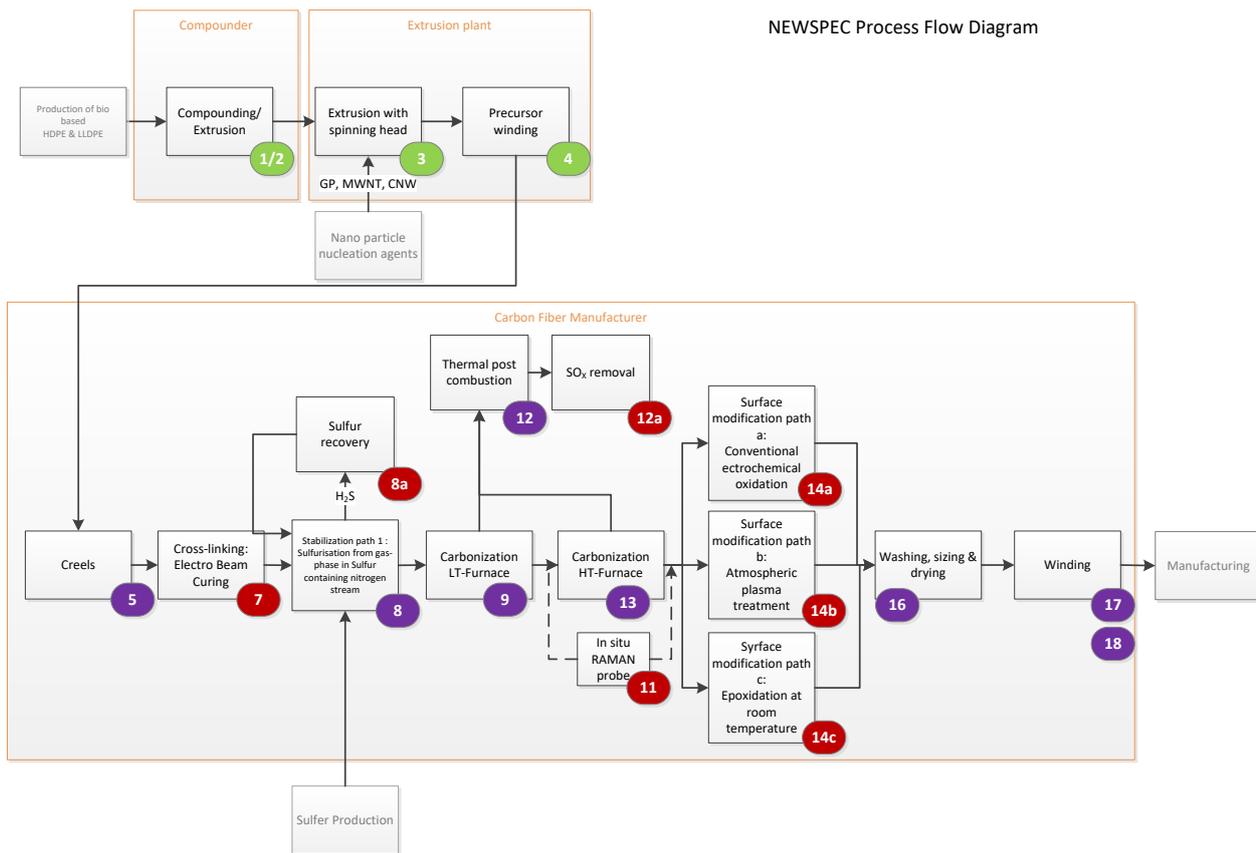


Figure 22 Process flow diagram of the NEWSPEC production process for PE based carbon fibres

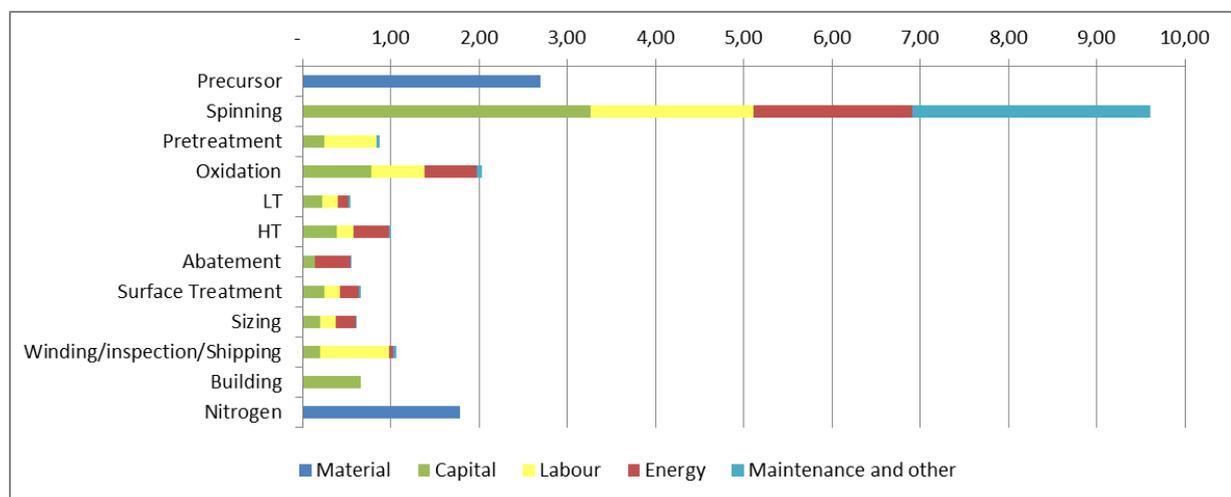


Figure 23: Estimated production costs for the conventional PAN based CF production

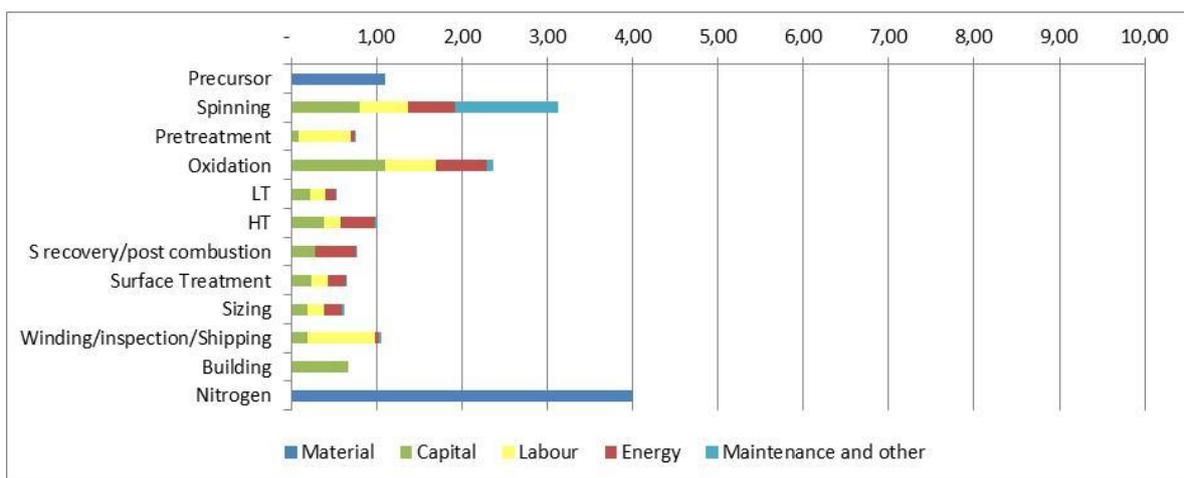


Figure 24: Estimated production costs for the NEWSPEC production process when low SRUs and abatement technologies are included

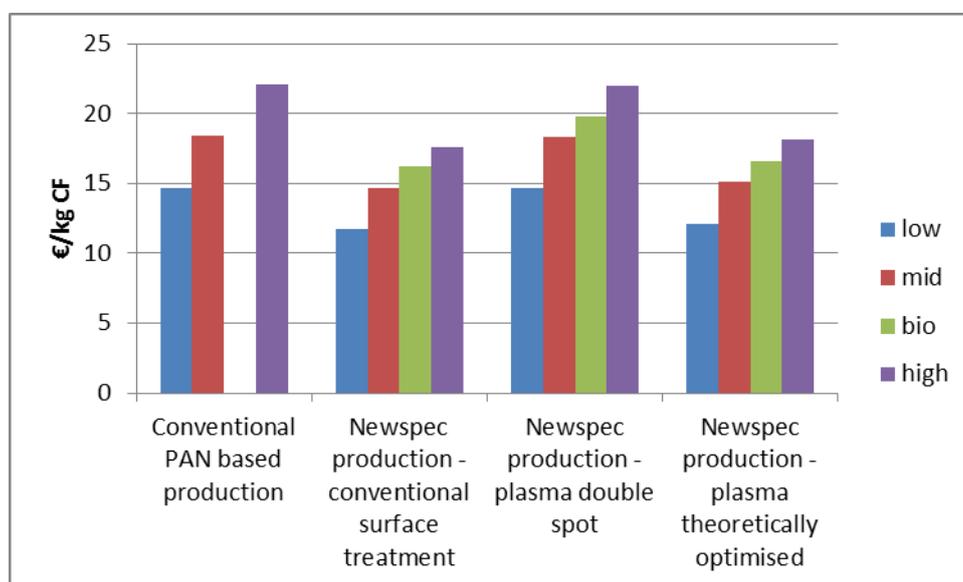


Figure 25: Results of cost estimates for the production of CF



Figure 26 NEWSPEC logo

PARTNERS

- Bremba
- WARRANT GROUP
- EUROPEAN COMMISSION
- EUROPEAN UNION
- TECUMSA
- VALFENI
- YUASAPO

NEWSPEC aims to develop new Carbon Fibres (CF) for aerospace, automotive, wind, oil and gas sectors applications through development of low-cost sustainable polyethylene (PE) precursor, bringing together the best available expertise across Europe.

NEW COST-EFFECTIVE AND SUSTAINABLE POLYETHYLENE-BASED CARBON FIBRES FOR VOLUME MARKET APPLICATIONS

NEWSPEC

Developing new precursors, new processing routes and functionalisations for carbon fibres

INNOVATION

The main objective of NEWSPEC is the development of CFs through promising low-cost polymers, such as polyethylene (PE).

Available PE precursor raw sources

PE is the carbon fibre (CF) feedstock for the production of high-strength, high-modulus carbon fibres.

Target goal

NEWSPEC aims to develop new Carbon Fibres (CF) for aerospace, automotive, wind, oil and gas sectors applications through development of low-cost sustainable polyethylene (PE) precursor, bringing together the best available expertise across Europe.

END APPLICATIONS

- Aerospace**: CF fabric, prepreg, woven fabric, prepreg
- Automotive**: Structural, body and chassis
- Automotive**: Low modulus prepreg
- Wind**: CF for blades (CF or prepreg) and CF prepreg for blades
- Oil and Gas**: PE-based prepreg for CF fabric prepreg for pipes and vessels

Figure 27 NEWSPEC brochure

www.newssec.eu

NEW COST-EFFECTIVE AND SUSTAINABLE POLYETHYLENE BASED CARBON FIBRES FOR VOLUME MARKET APPLICATIONS



The new frontier in the development, manufacturing
and application of low cost carbon fibres

OBJECTIVES

The main objective of NEWSPEC is the development of CFs through promising low-cost polymers, such as polyethylene (PE). PE presents interesting technical features like high carbon yield (around 70%), high processability and flexibility (many potential polymer modifications to examine) and very competitive cost (~2 euro/kg) with respect to PAN precursor which may result to precursor cost savings of up to 70%. Final PE-CF production cost equals to 10 euro/kg compared to about 15 euro/kg of PAN fibres, thus reaching 30% cost saving on similar production scales.

EUROPEAN COMMISSION RESEARCH

Project reference: 604168

Status: Ongoing (start date: 01 November, 2013)

Total cost: EUR 10 045 359

EU contribution: EUR 7 393 755

Programme acronym: FP7-NMP

Subprogramme area: NMP.2013.2.1-1

Contract type: Large scale integrating project

Propose a novel non-wet stabilization method that introduces heteroatoms at the precursor stage in combination with Electron Beam Curing (EBC) which makes the process very innovative, flexible, less time consuming and thus more economically viable.

Exploit the potential of nanomaterials – carbon nanotubes (CNT) and cellulose nano whiskers (CNW) – as nucleation agents to further reduce the requested stabilization time and the graphitisation temperature. Lowering the graphitization temperature from 1500° to 1200°C can contribute to cost reduction of about 15- 20% with respect to typical PAN process. This will also contribute to overall cost saving.

Innovative functionalization routes for the surface treatment of PE-based CF will be explored: (a) atmospheric plasma technology for controlled oxidation and grafting of other selected functional groups to the surface; (b) new methods of rapid room-temperature grafting on graphitic surfaces using specific surface attacking chemicals.

Set-up of a transportable confocal micro Raman system which will be used on the processing line for monitoring the various steps of CF synthesis.

Fundamental investigation and understanding of PE-CF/matrix interaction. Parameters such as Interfacial Shear Strength and the characteristic length scale (beta parameter) will be determined for various matrices and CF treatment and sizing.

INNOVATION

AEROSPACE

LOW LOADED, SECONDARY AIRCRAFT STRUCTURES

Aerospace market for CFs composites is driven by the significant weight and performance advantages. B787 and A380 aircraft, over 250 tons jumbo jets, use CF composites in almost 50% of the aircraft in weight and 80% composite by volume.

WIND

TURBINE BLADES > 50M LONG, & RETROFIT OF MEDIUM TURBINES <35M LONG.

The increasing dimensions of wind turbines blades will require an extensive use of high strength fibres due to the enormous tensile loads on rotors with large diameters and heavier mass.

OIL AND GAS

PIPELINES, PRESSURE VESSELS FOR OIL/GAS COMPONENTS FOR HARSH ENVIRONMENTS

Pressure vessels, oil and gas pipelines are subjected to severe stresses and operate in harsh working conditions and environments, like maritime climate conditions. Low cost CFRC can be used for strengthening and retrofitting of corrosion-damaged and distressed structures instead of glass fibres.

END APPLICATIONS



AUTOMOTIVE

BRAKE ROTORS AND PADS

The use of carbon ceramics materials will revolutionize also the automobile brakes. In comparison to the conventional grey cast iron brake disk the carbon brake disk weighed round 50% less reducing the unsprung mass by almost 20 kg. Further significant advantages are related with enhanced mechanical and thermal properties. Lower costs CFs will help ceramic brakes (CCM) to be deployed in mass market vehicles, especially where lightweight is a must like for instance electric cars.

AUTOMOTIVE

STRUCTURE, BODY AND INTERIORS

CF reinforced composites and plastics (CFRP) are increasing either for body or chassis components. Forged CFRP exhibit higher modulus and lower specific gravity relative to glass fibres as the modulus of commercial-grade CFs is more than four times higher than E-glass fibres. Less expensive PE-CFs for about 30% vs PAN can contribute to save up to 25% of costs thus opening perspectives for deployment of fibres into high-end segment cars.



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Figure 28 NEWSPEC poster

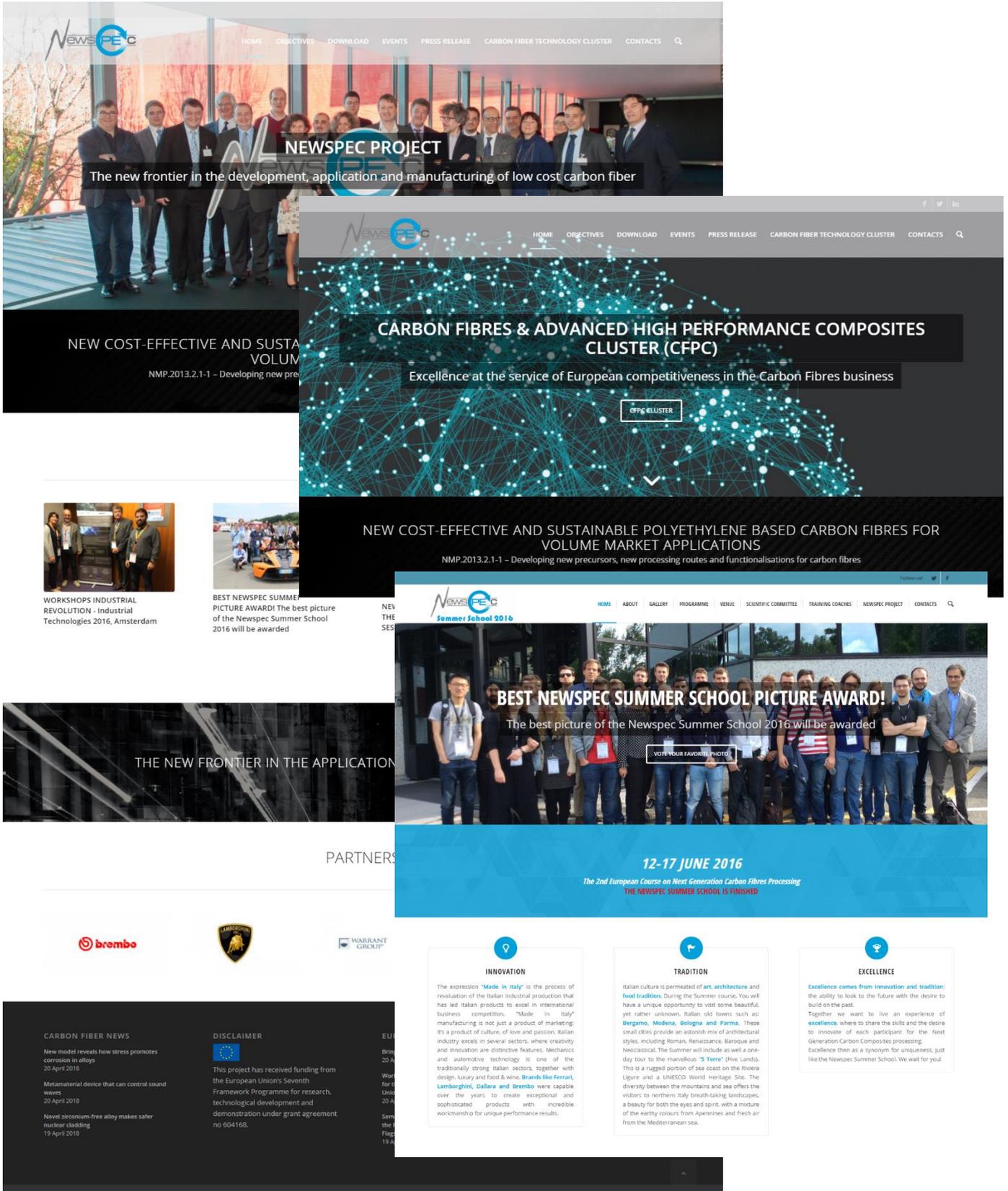


Figure 29 NEWSPEC website

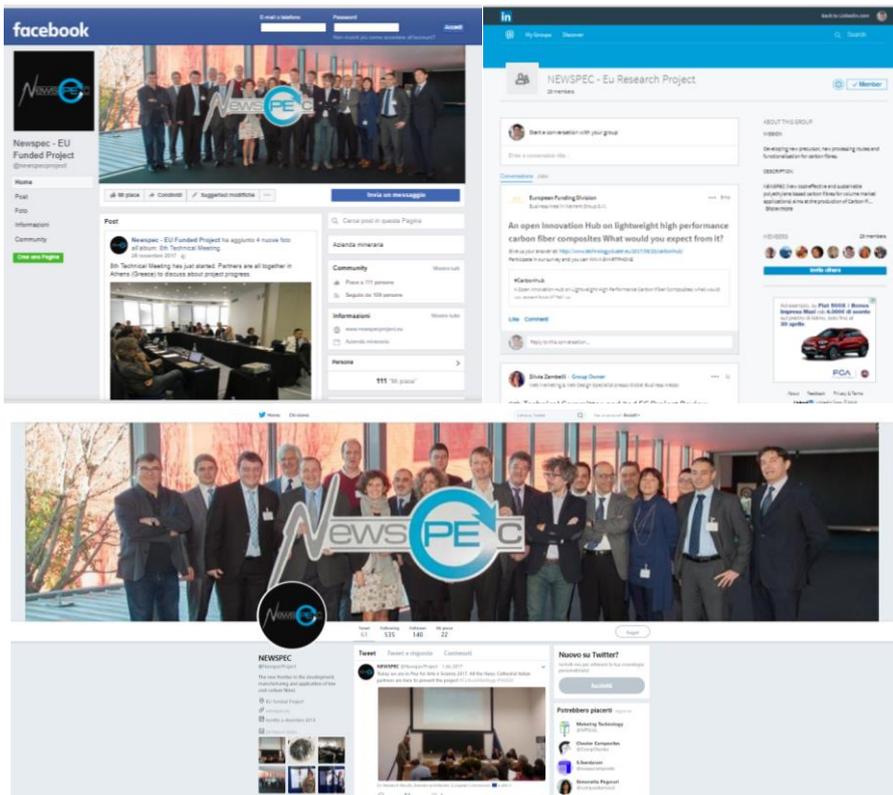


Figure 30 NEWSPEC Social Media



Figure 31 NEWSPEC 2nd SummerSchool



Figure 32 NEWSPEC Final Meeting