ENERGY

Polymer-based composites

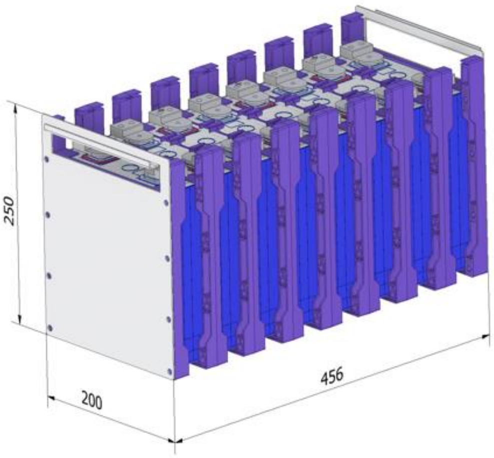
17_ENER_PBC_BATTERYpack

Title: Modular battery pack for Li-Ion technology

Summary: Main purpose of the modular battery pack is to design a product, that will provide a strong and lightweight base for modular battery pack assembly.

Scope: We are developing new modular battery packs for Li-Ion technology and for this purpose, and are looking for new designs with advanced materials, that could improve the quality and durability of the battery housing.

- The new housing design will be used in different applications, ranging from material handling batteries, to stationary applications for energy storage.
- To ensure longevity for the product and to extend its life expectancy, the new housing must fulfil special requirements, that are described in objectives.
- The battery housing must fulfil requirements described in Ecodesign directive (2009/125/EC).
- We are looking for companies, that have extensive knowledge in advanced materials and product design.



Objectives:

- New product design, that fits required dimensions.
- Lightweight product.
- Easy assembly and disassembly.
- Product must sustain 300kgf on prismatic cell walls.
- Thin side walls for easy cells insertion.
- Product design prepared for automatic assembly.
- Use of recyclable or reusable materials is advantageable.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101005435

18_ENER_PBC_LightHtank

Title: Lightweight gaseous hydrogen storage tank for aeronautical application

Summary: Hydrogen application is one of the most promising solution to decarbonize the aeronautical industry. The storage of hydrogen in a lightweight tank is one of the biggest challenge. This project proposes to develop a new type of tank in order to make gaseous hydrogen storage a feasible solution for aviation. New composite materials could be investigated as well as new design for the tank.

For our airship application, 6000 T of CO_2eq can be saved per airship and per year if using hydrogen instead of kerosene, and we plan to manufacture and operate 100 airships for the first 10 years.

Scope:

Hydrogen will be the enabler to decarbonize aviation. However, it must be done without impacting the performances of the aircraft i.e. as light as possible.

Gaseous hydrogen storage is the most mature technology since it has widely been developed for automotive. But the aeronautical constraints in term of weight have not been considered.

Thus, there is a need to design gaseous hydrogen storage for aviation. The airship can therefore be a first application given the less constraining design, especially regarding the volume constraint: dozens of cubic meters. This leads to investigating big and light vessels with possibly lower pressure than the common 350 or 700 bars.

The outcomes of this project could be adapted not only to airships. Indeed, GH2 tanks are first easier to be designed with as few constraints as possible. So, not considering the volume constraint (for airship application) will help to converge on different architectures. Then, it will be easier to take account the volume variable for other applications such as maritime or in energy.

Objectives:

- The main KPI for developing a hydrogen tank for aviation is its weight.
- An output of the project could be a parametric model coupled with an optimization algorithm that proposes different gaseous hydrogen tank designs (variables = inner pressure, materials, manufacturing process, dimension(s) of the tank, etc).
- Challenge giver can provide the specifications for such a storage as well as some preliminary results.
- The model shall take into consideration new materials & processes and their compatibility with hydrogen, and tank design (parametric model).

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19_ENER_PBC_ETAlightFRP

Title: Energy harvesting by innovative Thermoelectrically-enabled Advanced structural & lightweight FRP composites

Summary: Printed thermoelectric generator (TEG) thin film-consisting devices onto glass fiber (GF) reinforcement substrates, and the integration of GF-TEG as functional/ system laminae in carbon FRP structural laminates for thermal energy harvesting could allow multi-functional lightweight structural with energy harvesting capabilities. TEG-enabled structural composites with energy power output of higher than 10mW (in several hot spots and thermal losses existing in structural composites) could allow the self-powering of low-power electronics for e.g. IoT sensors, machine-to-machine communication towards E-mobility, SHM functions, etc. This will a) increase the operational lifetime of structural composite materials, b) decrease the regular maintenance and inspection costs, c) increase the safety of the users (e.g. passengers in automotive, aeronautics, etc.) all of which could have a i) significant impact in the reduction of CO_2 emissions, and ii) decreased weight of the structures via decreased usage cables due to the "stand-alone" structural parts with energy harvesting capabilities that can power integrated electronics.

The above concept could be realised with TEG devices printed by sheet-to-sheet (S2S) & roll-to-roll (R2R) technologies on glass fiber substrates utilising highly efficient, abundant and environmentally friendly thermoelectric nanomaterial inks. Carbon nanoallotropes are envisioned to be the best candidate for printed TEGs due to their high thermal stability as well as the ease of tuning their semiconductor characteristics (p- and n-doping efficient processes, engineered shift of Fermi level, etc.).

Representative Target values: power factors PF> 100 μWm-1K-2 for p- and n-type materials, and ZT: 0.1-1.0) reaching TEG device efficiency of n= 5-10%. Lifetime of TEG devices >10 yrs with proper Effective Encapsulation.

Selected sectors of application: Automotive (e.g. Automotive: TEG-enabled FRP bonnets); Aeronautics (TEG-enabled FRP leading edge, fuselage, etc.); Aerospace (TEG-enabled FRP coverage of Radioisotope TEGs, etc.). Start TRL4-5, end TRL7.

Scope:

- Printed TEGs on glass fiber reinforcements (woven or non-woven substrates) at large scale with a power output of Pout>10mW at ΔT = 100 K
- TEGs with nanomaterials exhibiting a thermoelectric figure of merit (ZT) >0.1 and up to ZT=1.0, allowing TEG device efficiency of n= 5-10%.
- Proper doping of carbon nanomaterials is missing to go achieve ZT>0.1; while keeping environmentally friendly solvents e.g. water for the inks medium
- Integration of flexible GF-TEG laminae in structural FRP laminate composites for the efficient thermal energy harvesting and utilisation of the energy produced by the advanced composites for self-powered low-power electronics

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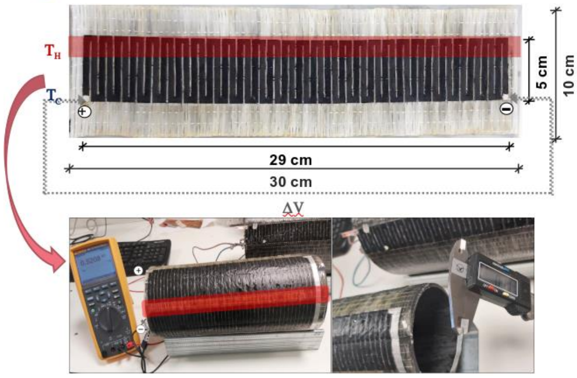

Figure: Printed TEG on a glass fabric and integration in a tubular FRP structure

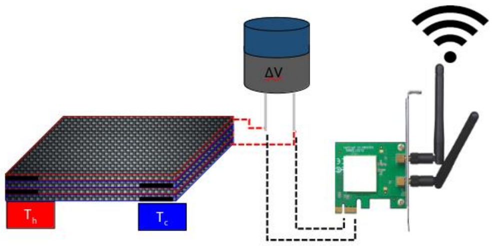

Figure: TEG-enabled structural FRPs for self-powered functions…

Objectives:

- Seebeck coefficient and conductivity of p- and n-type semiconductors via e.g. doping with acidic- proton donating conjugated (p-doping) and conjugated amines/ base molecules for e-donation (n-doping): Performance Targets: Seebeck coefficient S >50 μV/K for p-doped and <-40 μ V/K for n-doped nanomaterials, electrical conductivity σ = 104 S/m with power factors PF> 308 μW/mK2 and 258 μW/mK2 for the p-type and n-type films, respectively at ΔT=100K (KPI-01):
- Power Factors (PF = σ S2) increase by at least 2-3 times for carbon nanoallotrope thermoelectrics; and figure of merit (ZT) from 0.1 (currently achieved) to be increased to ZT = 0.5-1.0 (KPI-02),
- Power conversion efficiency (PCE) from current values of 2-3% to PCE or n=5% (KPI-03) at material level
- The TEGs onto glass fiber reinforcements to be highly scalable fabricated in a continuous printing process (KPI-04)
- TEG Devices for TEG-enabled FRPs with the ability of operating at high temperatures up to 200°C at ambient conditions (1 atm, relative humidity: 50±5% RH) (KPI-05)
- Maximum power density of the TEG device >5 W/m2 and 10.0 W/m2 at ΔT=50K and ΔT=100, respectively (KPI-06)
- TEG-enabled FRPs (TRL7) with self-powered capabilities e.g. powering a strain gauge sensor for SHM, a temperature sensor, etc. (KPI-07: demonstration of the FRP produced energy for a self-powered function)

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20_ENER_PBC_CFNWfabric

Title: Carbon fiber spayed non-woven fabric

Summary: The basic problem is to produce a non-woven carbon fiber non-woven material from recycling, mainly from pyrolysis. The problem is that the existing textile techniques should be adapted to the needs of producing carbon nonwovens of appropriate quality, enabling their further use - processing. According to our tests, the production of such nonwovens is possible by combining several techniques known from the textile industry, including: needling, binder spraying combined with calendering, sewing, e.g. with the Maliwat technique.

In case of great problems with achieving cohesion after needling, it is possible to add other fibers improving the cohesion of the non-woven fabric, including natural fibers.

Scope: Carbon nonwovens are currently produced mostly by needling, we want to produce them by blowing them without needling. Currently, we do not know the possibility of such production.

Should be also examined the market to see if there is a demand for such nonwovens.

Objectives:

- to create inflatable nonwovens
- the pyrolysis process we have carried out allows the recovery of long fibers, up to 2 meters in length, which allows the creation of nonwovens from longer threads, which will significantly affect the strength of the non-woven fabric.
- creating a closed loop for carbon fiber
- new product on the market
- Possibility of cooperation with biggest producers and recyclers of such.

The main goal is to obtain nonwovens made of pyrolytic carbon fibers suitable for the formation of:

a) pre-impregnates

b) nonwovens for infusion and RTM techniques

c) stitched nonwovens for the production of open and closed profiles using cheap techniques

d) manual lamination.

Referring to the current geopolitical situation, the techniques and materials from the submitted task will enable the production of cheap drones and other military flying means that strengthen defence.

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