



Riunione biennale
CMAEL- GUSEE 2023

E-MOBILITY:
PROSPETTIVE
dell'ELETTRIFICAZIONE IN
CAMPO AERONAUTICO

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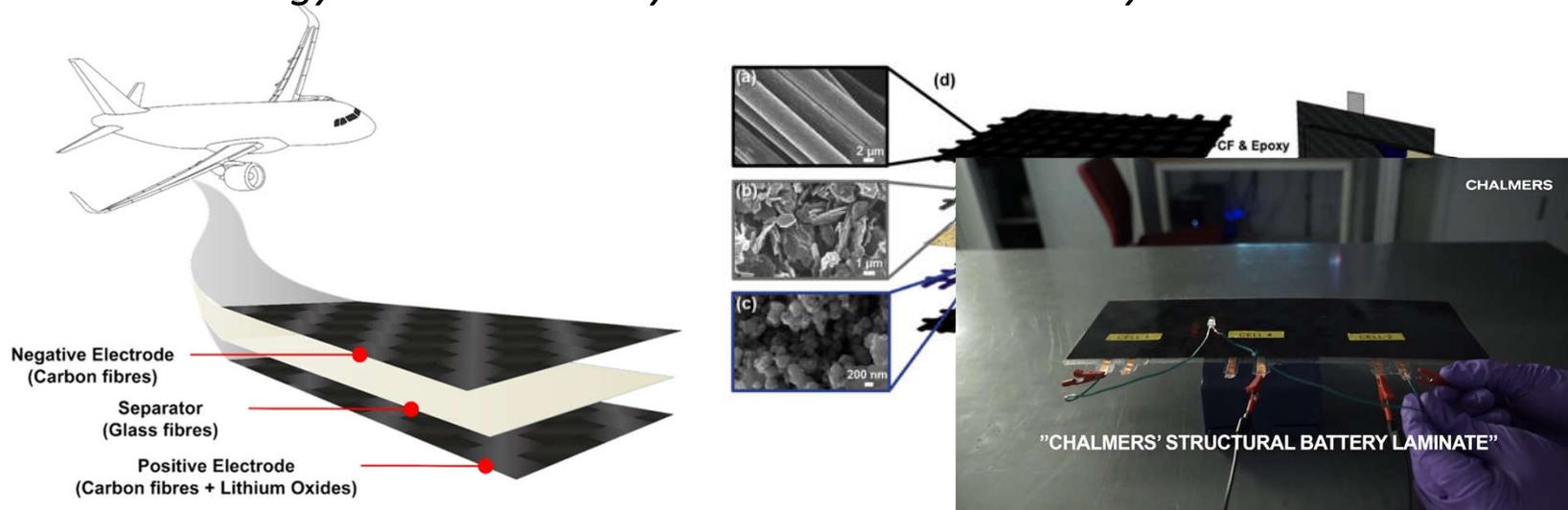
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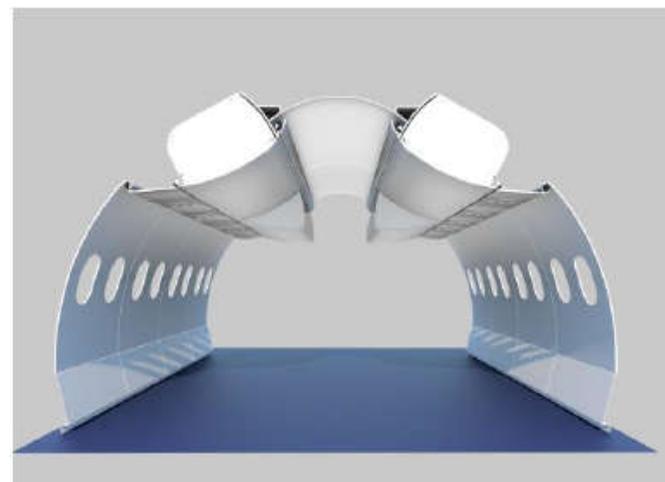
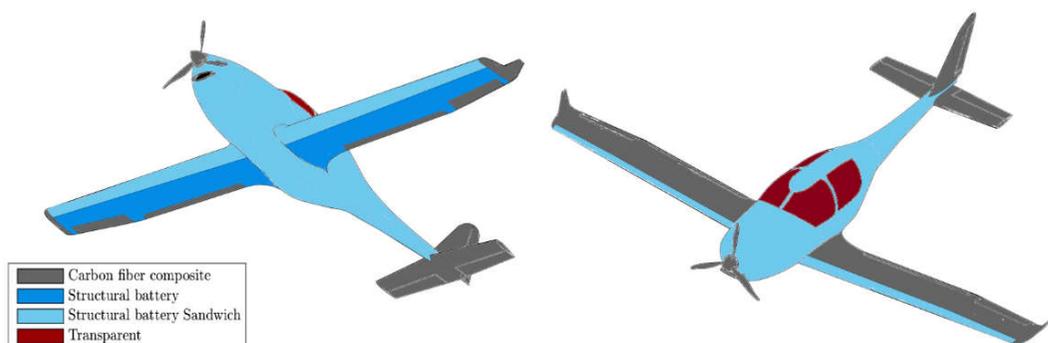
Concept for Structural Batteries



Structural batteries are hybrid and multifunctional composite materials able to carry load and store electrical energy in the same way as a lithium-ion battery.



Structural Batteries possible applications



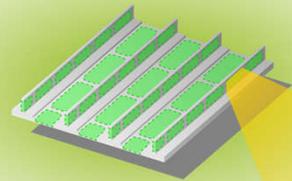


aircraft with structural battery

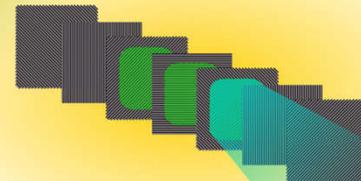


Pipistrel PVK-1 Miniliner Concept

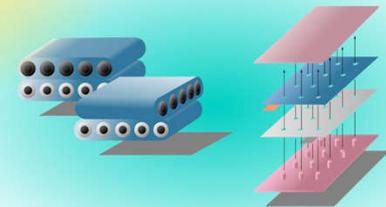
multifunctional aeronautic part -
structural battery module



multifunctional composite laminate -
structural battery cell



structural electrochemistry



SOLIFLY
developing structural batteries towards aeronautic applications

Founded by H2020 Clean Sky 2 | Semi-solid-state Li-ion batteries functionally integrated in composite structures for next generation hybrid electric airliner

SOLIFLY Demonstrator

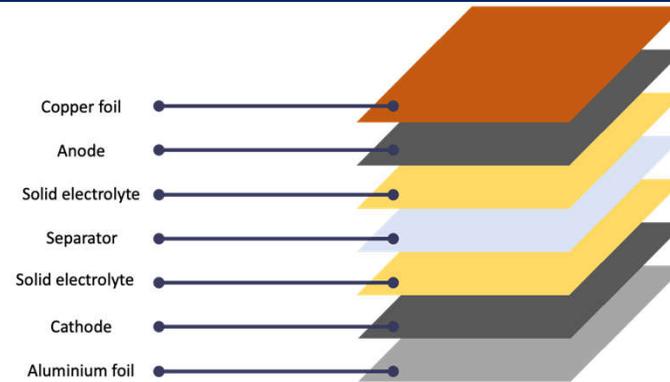
- Representative aeronautic part: **Stiffened panel** (70 cm x 40 cm)
- 100 – 180 Wh/kg at cell level
- nominal discharge rate up to 1C
- 300+ cycles at 0.1C with 90% capacity retention

TRL4 (2023)



Laminated SB configuration proposal

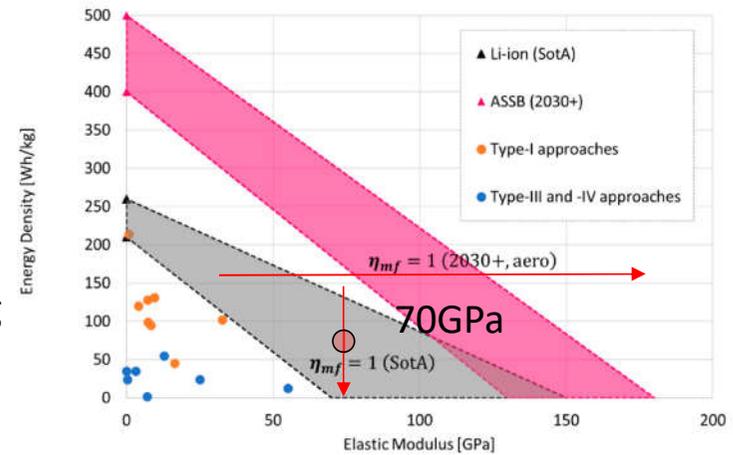
- ANODE: IMS65 or T300 fibers (twill or satin).
- SEPARATOR: glass-fiber weave.
- CATHODE: functionalizing carbon fibers with $LiFePo_4$.
- BINDERS: copper & aluminum foils.
- ELECTROLYTE: Solid electrolyte.



Quantity	CFRP	SB
Mass density (kg/m^3)	1,600	1,800
Tensile modulus (GPa)	70	70
Shear modulus (GPa)	5.2	5.0
Ultimate tensile strength 0° (MPa)	600	560
Ultimate compression strength 0° (MPa)	570	280
Ultimate tensile strength 90° (MPa)	600	560
Ultimate compression strength 90° (MPa)	570	280
Ultimate in-plane shear strength (MPa)	90	52
Ply thickness (mm)	0.20	0.275

Battery type	Conventional	Structural
e_b (Wh/kg)	265	75Wh/kg
p_{b-peak} (W/kg)	2,600	
p_b (W/kg)	900	150W/kg

75Wh/kg
SoTA (2025)



Certification Requirements for Composite Structures

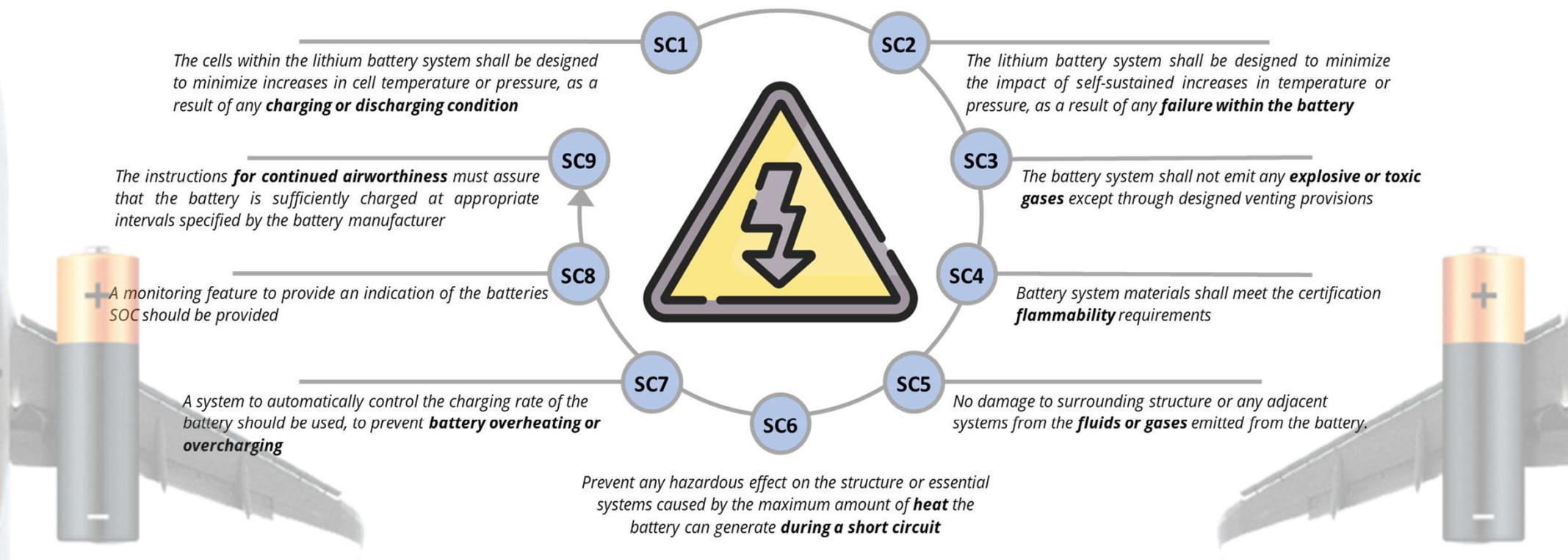


The first step for certification of any advanced material and process is the materials and processes control. Three items to define and control:

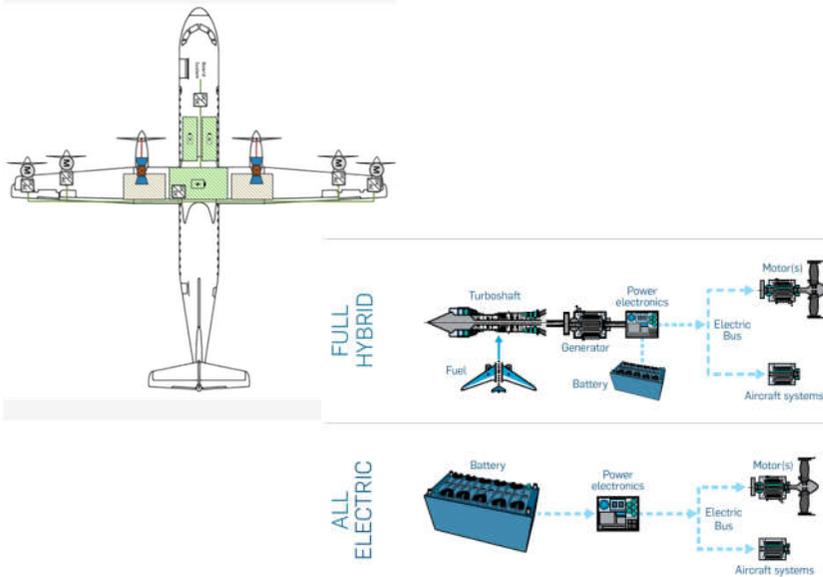
- ❖ Feedstock material
- ❖ Process to convert to a part
- ❖ Final part material

The most widely used standard for verifying the airworthiness of a composite material is the FAR part 25 from Federal Aviation Administration. The AGATE and NCAMP programs are two databases that provide a list of certified composite materials.

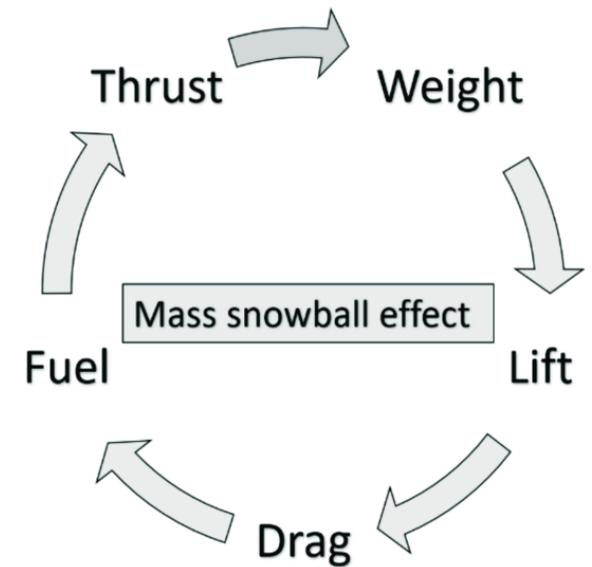
Certification Requirements for Lithium Batteries



Mass snowball effect



The addition of “extra” mass (i.e., batteries) triggers the snow ball effect on the aircraft weight.



The higher the power required from batteries the larger the A/C weight.

Whatever is the configuration and the power train architecture, all those solutions increase the aircraft weight by introducing the battery mass needed to fulfil the energy requirements.



Thank you for
the attention