Structural Energy Storage

En route to "Massless Energy"

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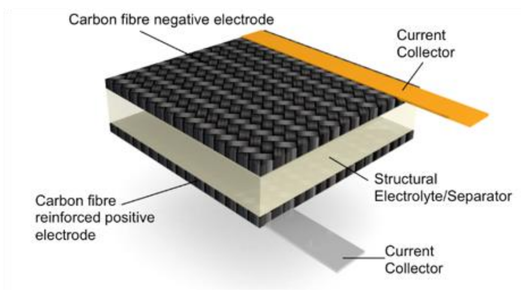
Structural pOweR CompositEs foR futurE civil aiRcraft

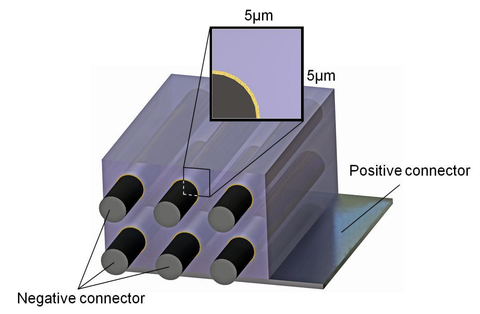
Structural power composites are structural composites with the additional functionality of storing electrical energy. The concept is based on the fact that carbon fibers can offer several functions: high stiffness and simultaneously being used as active electrodes. Combined with a multifunctional matrix allowing not only for load transfer but also for ion-conductivity, multifunctional carbon fibre composite laminates can be made with either an integrated supercapacitor or battery function. Compared to two monofunctional systems, a structure and a separate energy storage device, multifunctional structural power composites will have a lower mass while providing the same structural and energy storage functions, offering a new approach to enhancing sustainability in several Sectors.

Structural Batteries

A novel Li-ion battery material is being developed employing carbon fibres as combined electrode and reinforcement, and structural battery electrolytes as the matrix for simultaneous Li-ion transport and mechanical load transfer. Two architectures have been conceived for making such structural batteries: the laminated battery and 3D micro battery, which rely on access to a highly ion conductive, and stiff, solid polymer electrolyte.



The concept of a laminated structural carbon fibre battery architecture.



The concept of a 3D structural carbon fibre micro battery architecture.

Structural Supercapacitors

For applications in which energy delivery (i.e. power) and cyclability, rather than energy capacity, is required, an alternative to batteries are supercapacitors. These devices store energy through accumulation of ions at the electrodes. Structural supercapacitors have two high surface area electrodes sandwiching a separator, all infused with a structural electrolyte. Two materials are being investigated for making such structural supercapcitors: carbon nanotube fibres and carbon aerogel modified carbon fibres structures.

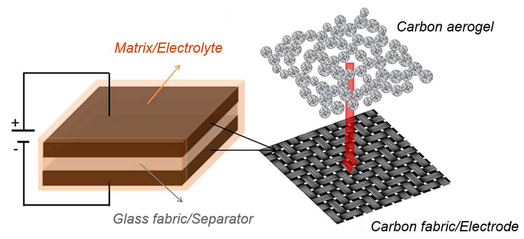
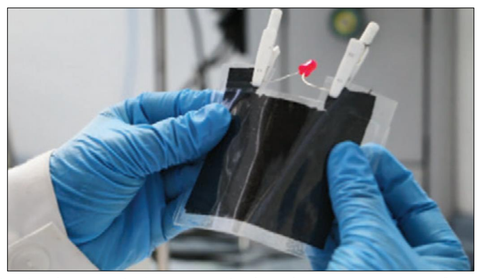
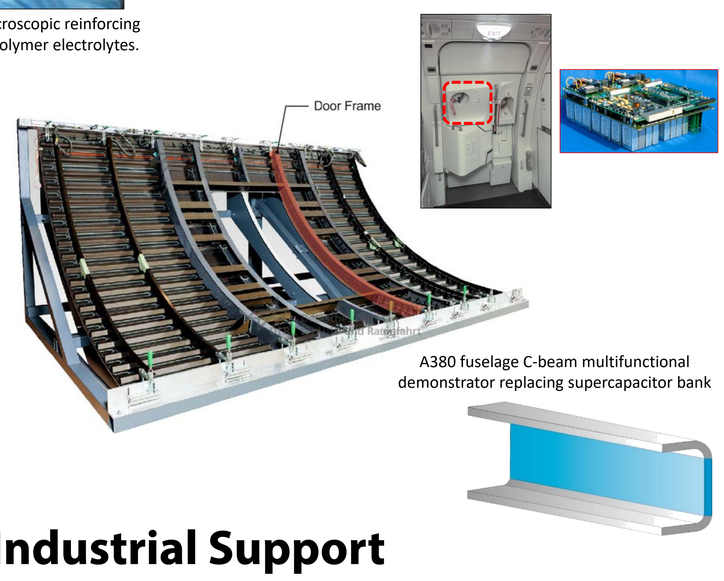


Illustration of a structural supercapacitor.


Structural energy storing composites based on macroscopic reinforcing fibres, high-capacitance fabrics of CNT fibres and polymer electrolytes.

Industrial Outlook

Considerable hurdles still must be overcome for structural power to be fully adopted by industry. Fundamental challenges include improved understanding of the interaction between electrical and mechanical behaviour, performance at temperature extremes and durability. Practical issues, such as accessibility, replaceability, sensing and battery management will also have to be addressed. A particular challenge associated with Aerospace is addressing certification of structural power materials such that they are deemed airworthy.



A380 fuselage C-beam multifunctional demonstrator replacing supercapacitor bank

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