Editorial corner – a personal view Added function – Added value: Multifunctional high-performance composites

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All materials are functional materials. If not, why else would one develop materials? Materials carry load, can be used to produce or harvest, transmit and store electrical energy or are thermal and electrical conductors or insulators. Materials can be ‘smart’, ‘responsive’, ‘reactive’, ‘self-healing’, ‘bio-inspired’ etc. By combining structural properties with additional integrated optical, magnetic, electrical or thermal functionalities into a single material, multifunctional materials are created (DOI: [10.1016/j.compositesa.2012.10.007](https://doi.org/10.1016/j.compositesa.2012.10.007)). A multitude of biological materials are multifunctional, for example bone – a structural, rigid, self-healing organ that also acts as bioreactor, producing red and white blood cells. Bones are living hierarchical composites with a layered structure. Composites are materials consisting of at least two identifiably different materials, which combined together, have an engineering performance that by far exceeds those of the individual constituents. High performance fibre reinforced polymer composites are now used in cars and (plastic) airplanes. In composites, fibres carry load and the fibre type, alignment, orientation determine the overall mechanical properties while the polymer matrix protects and holds the fibres in place, and transfers the load between the fibres. The structure of composites can be tailored for functionality by combining separate components; sensors, cables and even batteries can be integrated into composites (DOI: [10.1016/j.compscitech.2008.02.019](https://doi.org/10.1016/j.compscitech.2008.02.019)). However, this comes at a cost; it adds additional weight. The more challenging approach is to design a single material to perform more functions, for instance to carry significant mechani-

cal load and simultaneously store and deliver electrical energy (DOI: [10.1016/j.compositesa.2012.10.007](https://doi.org/10.1016/j.compositesa.2012.10.007)). Carbon materials are both a structural composite reinforcement and a common electrode component. Moreover, both structural composites and electrochemical devices are often laminates but the requirements for structural fibres and electrode materials are different; one has to be strong and stiff while the other has to be electrically conducting with a high surface area to either allow for the formation of an electrochemical double layer (supercapacitors) or intercalate lithium (batteries). In batteries and supercapacitors, the electrodes need to be separated to avoid short-circuiting and the matrix is usually a liquid electrolyte. These requirements pose significant challenges for structural materials. Recent research (DOI: [10.1039/C4FD00055B](https://doi.org/10.1039/C4FD00055B)) has been addressing some of the challenges aiming to develop structural electrodes and solid polymer electrolytes, which are both structural but also allow for sufficient ion conductivity. Successful structural energy storage systems could sacrifice some mechanical and electrical performance and yet offer attractive solutions to reduce the overall weight of a structural component.

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