Nanostructured fibres and fabrics for structural supercapacitor composites

Juan J. Vilatela
Evgeny Senokos, Rebeca Marcilla, Jesús, Palma

IMDEA Materials, Getafe, Spain
IMDEA Energy, Móstoles, Spain

juanjose.vilatela@imdea.org

There is an ever increasing interest in multifunctional materials such as energy managing devices that have non-conventional mechanical properties. These include supercapacitors and batteries that are flexible, stretchable, tough and ultimately, that have structural properties. In particular, there is a great potential in exploiting the inherent layered structure of these devices in a structural composite architecture. In the context of structural supercapacitors, the two main challenges are: increasing the intrinsically low surface area of carbon fibre ($0.2 m^2/g$), and producing a solid electrolyte with both high stiffness and ionic conductivity. This work introduces macroscopic fibres and fabrics of carbon nanotubes (CNT) as an attractive component for structural supercapacitors. The fibres have electrical conductivity above steel, tensile properties in the high-performance range, and more importantly a large surface area (250m2/g). CNT fibre unidirectional fabrics can be pressed with a thermoplastic polyelectrolyte to produce large ($100 cm^2$) all-solid supercapacitors with specific power and energy densities as high as 46kW/Kg and 11.4Wh/Kg, with > 97% stability after 10000 charge-discharge cycles at 3.5V. The devices preserve these properties while bent 180° and have specific tensile strength above that of copper (40 MPa/SG). The talk presents recent progress in introducing these high energy-density films in laminate CF/epoxy composites to produce a hierarchical multifunctional structure. Galvanostatic charge-discharge (CD) measurements are performed *in situ* during during the mechanical tests give an indication that the limits of electrochemical operation comply with the expected deformations of the laminates in a structural element. Finally, figures of merit for multifunctionality are presented to compare results with the state-of-the-art and evaluate prospects for improvement by introduction Faradaic reactions.

References

[1] Senokos et al, Adv. Mater. Technol. (2017) 10.1002/admt.201600290

Figures

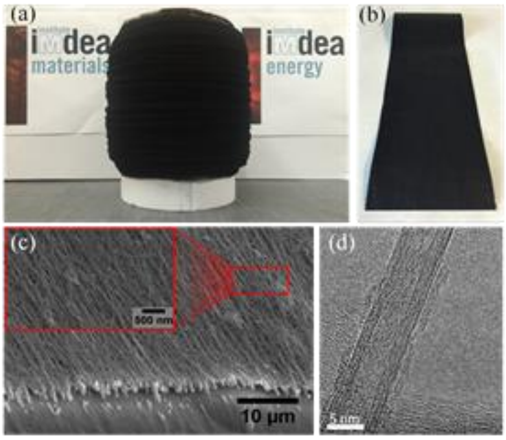

Figure 1: CNT fiber sheet electrode

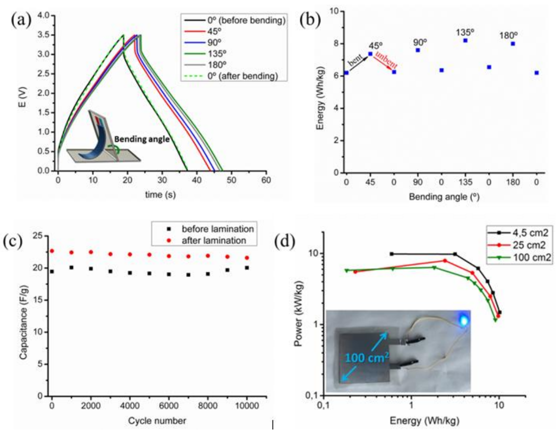

Figure 2: Electrochemical properties of devices and operation of devices under bending.