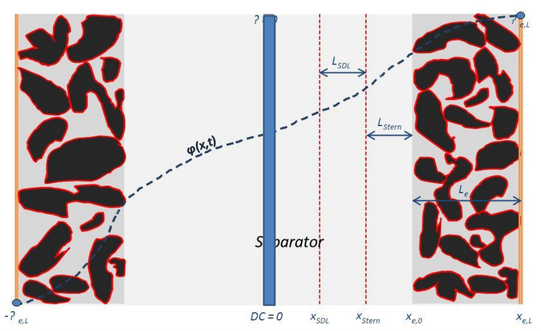
DEVELOPMENT OF HIGH ENERGY/HIGH POWER DENSITY SUPERCAPACITORS FOR AUTOMOTIVE APPLICATIONS

SEVENTH FRAMEWORK PROGRAMME

AUTOSUPERCAP

Supercapacitors are essential in electric vehicles for supplying power during acceleration and recovering braking energy. High power and sufficient energy density are required for both an effective power system but also to reduce weight. We are aiming at developing supercapacitors of both high power and high energy density at affordable levels by the automotive industry, and of higher sustainability than many current electrochemical storage devices.

Principles of electrochemical double layer capacitor (EDLC)



WP1. MANAGEMENT

WP2. SPECIFICATIONS

WP3.POWER SYSTEM MODEL

WP4, WP5, WP6. MATERIALS

WP7. FABRICATION

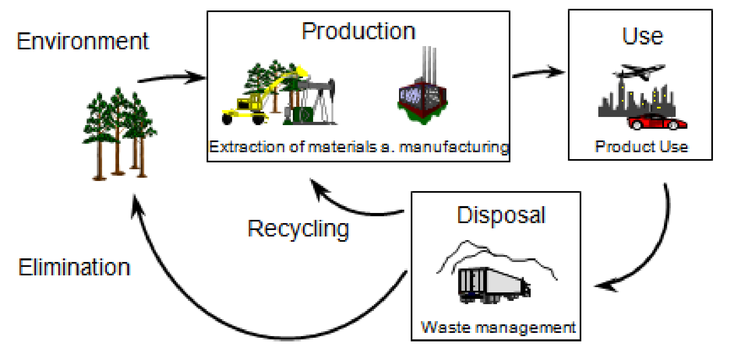
WP8. TESTING

WP9. RECYCLING

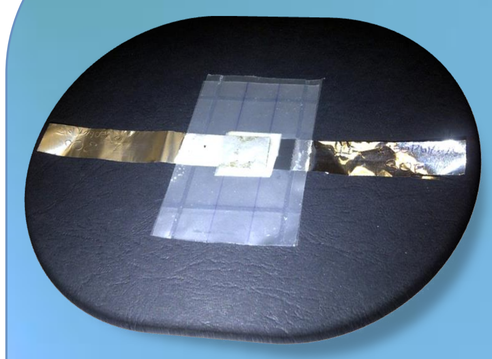
WP10 COST, LCA

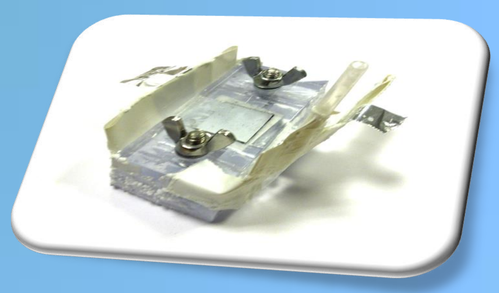
WP11. DISSEMINATION AND EXPLOITATION

Life Cycle Assessment (DIN EN ISO 14040 and 14044)



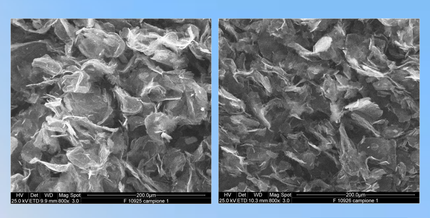
Small supercapacitor cells of 2 or 4 or 16 cm²



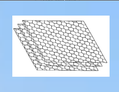


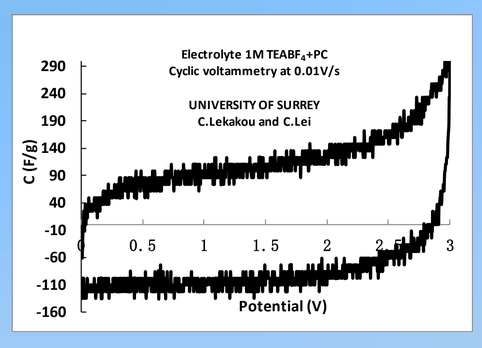
Graphene-based supercapacitors

THE "PETAL-LIKE" STRUCTURE CHARACTERISTIC OF A COMPLETE EXFOLIATION PROCESS

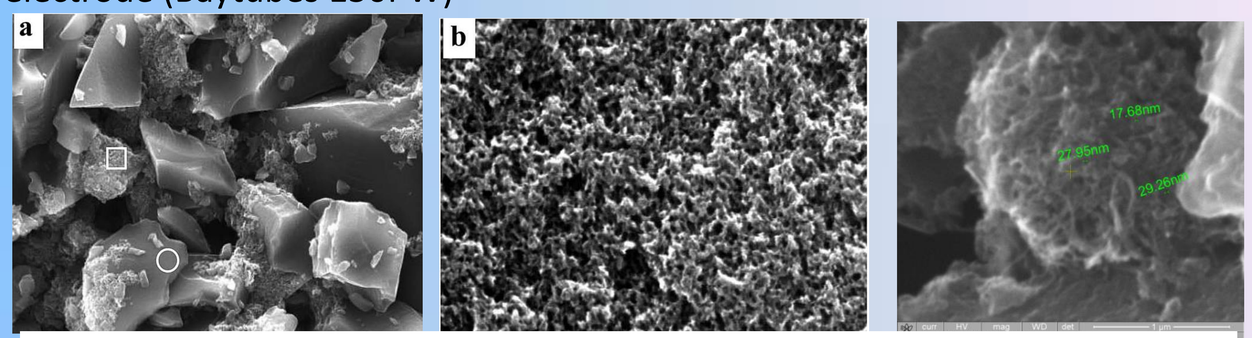


The softness of the single nanoplatelets can be explained assuming that each layer is made of very few graphene layers.



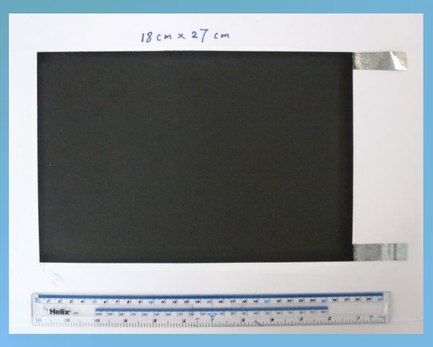


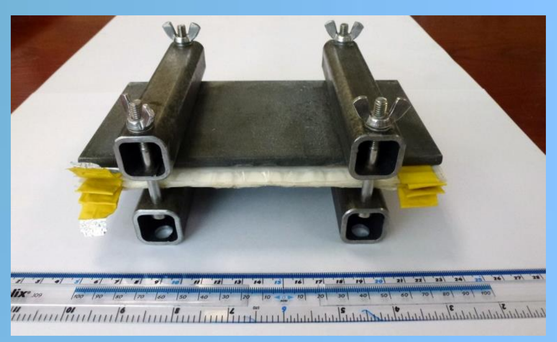
SEM image of coated carbonaceous electrodes : (a) AC and carbon black, x1k; (b) AC with C-46 (46% burn off in C activation) , x60k; (c) AC and MWNT-based electrode (Baytubes 150PW)

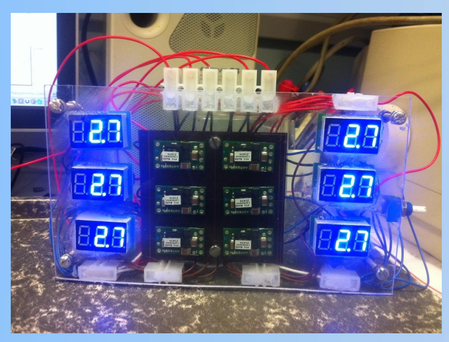


The emphasis in the first period of the project was on the development of novel materials and material combinations for supercapacitors, cell fabrication and testing of small supercapacitor cells, 2-16 cm². Materials considered for the porous electrodes were different types of activated carbon powder, activated carbon fabrics, multi-wall carbon nanotubes, and graphene. Carbon materials of various origins were tried and innovative treatments were developed in the project to reach a tested maximum power density of 18 Wh/kg, whereas the energy density varies, depending on material, from 10-18 Wh/kg to 24-40 Wh/kg. The addition of only a very small amount of MWNTs raises the tested power density to 40 kW/kg and the energy density to 20-26 Wh/kg.

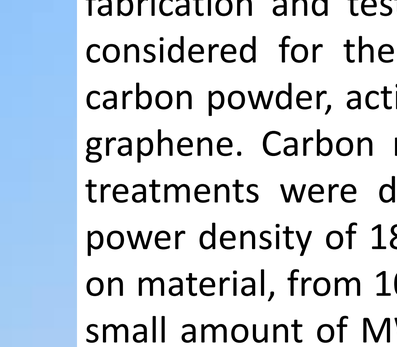
Work in progress







Cell balancing circuit with adjustable set points for Vmax for each cell



Infiltration studies for optimising the distribution of electrolyte

Issues and problems in the scaling up of electrode and cell fabrication for the manufacture of a supercapacitor module of 18 V and 4-5 kW

- Surface adhesion problems between the coating and current collector for roll-to-roll industrial production of coating; if more binder is added, resistance is too high for supercapacitor applications.
- Large area cells may suffer from poor or inhomogeneous impregnation by the electrolyte, yielding dry or partially filled regions.
- Difficulties in the sealing of cell pouch under vacuum if the electrolyte solvent is volatile.
- Novel design for the cell operation under compression, without adding extra weight or heavy plates.

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