Graphene based supercapacitors: results and perspectives

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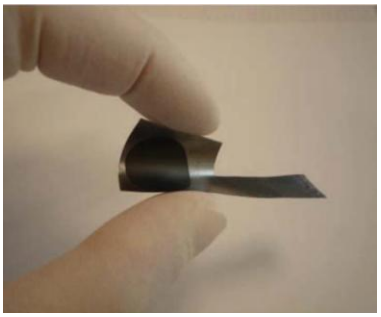
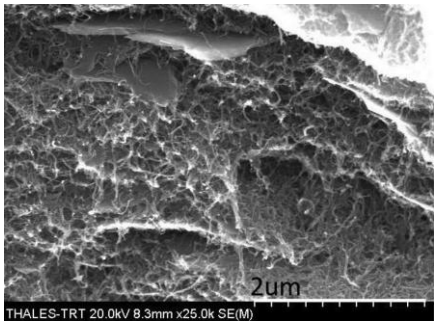
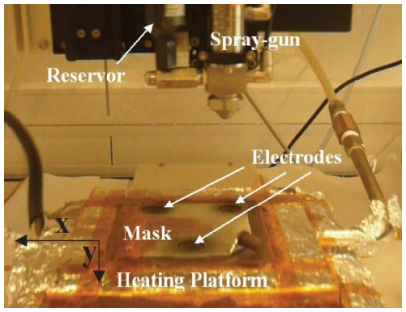
Supercapacitors are electrochemical energy storage devices that combine the high energy-storage-capability of conventional batteries with the high power-delivery-capability of conventional capacitors. In this contribution we will show the results of our group recently obtained on supercapacitors with electrodes obtained using mixtures of carbonaceous nanomaterials (carbon nanotubes (CNTs), graphite, graphene, oxidised graphene). The electrode fabrication has been performed using a new dynamic spray-gun based deposition process set-up at Thales Research and Technology (patented). First, we systematically studied the effect of the relative concentrations of Multi-Walled Carbon Nanotubes (MWCNTs) and graphite on the energy and power density. We obtained a power increase of a factor 2.5 compared to barely MWCNTs based electrodes for a mixture composed by 75% of graphite. This effect is related with the improvement of the mesoporous distribution of the composites and to the increase of the conductance as pointes out by Coleman et al. After these results, we decided to test water as a solvent in order to reduce the heating temperature and to obtain a green type process without toxic solvents. To achieve stable suspensions we oxidised the graphene and the CNTs before putting them in water. We observed that changing the Graphene Oxide concentrations we obtained different value of capacitance and energy. The best results were obtained with 90% of GO and 10% of CNTs. We obtained 120F/g and a power of 30kW/Kg. The importance of these results is that it is the first time that these performances have been obtained for graphene related materials using an industrial fabrication suitable technique that can be implemented in roll-to-roll production. In this way we were able to fabricate stable suspensions in less than one hour compared to three days using NMP. All these results demonstrate the strong potential to obtaining high performance devices using an industrially suitable fabrication technique. Finally, new results using mixtures of Carbon nanofibers and graphene will be shown. These new composite allow to use ionic liquid as electrolytes and so to increase dramatically the energy stored in the device without reducing the power.







References

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Dr. Paolo Bondavalli, Msc, PhD, Hdr is the Head of Nanomaterial team at Thales Research and Technology (CNRS/Thales, UMR137) and he is a member of the Nanocarb Lab. (joint team Ecole Polytechnique/Thales). His research has principally dealt with carbon nanotubes gas sensors and silicon nanowires for biological detection. In the last two years, he is the first author of several scientific papers (see refs in project) dealing with CNTFET based sensors, supercapacitors and of 6 patents dealing with gas sensors, thermal management through CNTs, nanomaterials deposition, supercapacitors and memristor-like structures. Presently his work is focused on the development of new materials (e.g. graphene, cnts, nanowires) for the new generation of electronics devices and for energy storage applications and memristor. Dr Bondavalli has received his Hdr in 2011, at Paris-Sud on a work on “devices based on random network of carbon nanotubes”. He is EU expert, and Vice-Chairman, for Marie Curie Fellowships (EIF, IIF, OIF, CIG, IRSES), NMP and ICT panel, for the French National Research Agency (ANR), EDA, Eureka and reviewer for IOP, ACS, IEEE, ECS, Elsevier, EPJ B, Bentham, Taylor & Francis... During the last five years, he has participated, also as coordinator, in several EU projects (concerning MEMS, MOEMS, CNTs, graphene, spintronics) and ANR projects. He is involved in the Graphene Flagship initiative.