Graphene based electrodes for high performances supercapacitors

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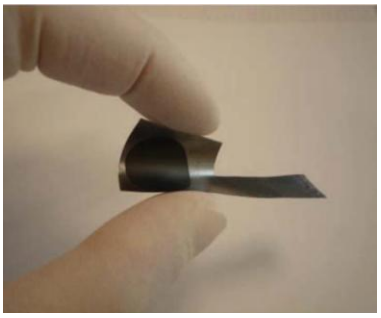
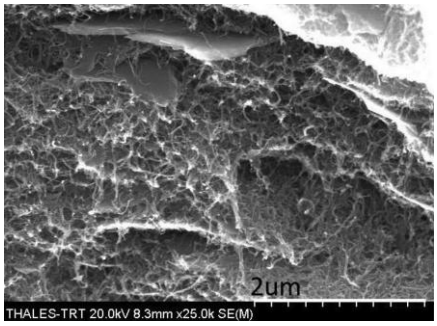
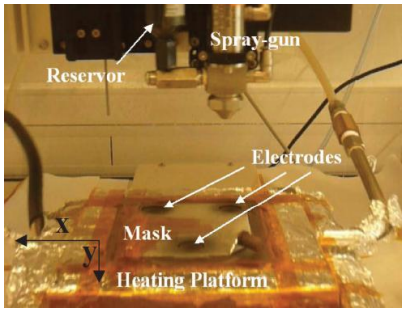
Supercapacitors are electrochemical energy storage devices that combine the high energy-storage-capability of conventional batteries with the high power-delivery-capability of conventional capacitors. In this contribution we will show the results of our group recently obtained on supercapacitors with 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). This technique constitute a real breakthrough compared to the classical filtration method because electrodes can be deposited over large areas in a completely automated way, using different kinds of substrates and with a thickness between some nm and up to hundredth of µms. In a first step, we will show the properties of mixtures of graphite/CNTs as a function of their composition (%) and of their weight for the fabrication of electrodes and cells. In order to spray the nanomaterials on a substrate we put them in stable suspensions using specific solvents. In case of CNTs/Graphite we used N-Methyl-Pyrrolidone. To avoid the “coffee-ring” effect” we have to heat the substrate and to reach the boiling point of the solvent (~220°C for NMP). The supercapacitor electrodes were fabricated on low cost graphite current collectors (commercially available) which are flexible and highly conducting. First, we systematically studied the effect of the relative concentrations of CNTs and graphite on the energy and power density. We obtained a power increase of a factor 2.5 compared to barely CNTs based electrodes for a mixture composed by 75% of graphite. 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. In this way we were able to fabricate stable suspensions in less than one hour compared to three days using NMP. Finally we will show recent results obtained using graphene exfoliated by IIT, that allows us improving the power of the supercapacitors in a dramatic way, thanks to its high conductivity. All these results demonstrate the strong potential to obtaining high performance devices using an industrially suitable fabrication technique.







References

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