Playing with nanostructuration of 1D and 2D nanomaterials : perspectives for new applications

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Abstract (Calibri 11)
This contribution deals with the fabrication of devices based on graphene based nanomaterials using dynamic spray-gun deposition method implemented through roll-to-roll. This technique has been developed at Thales and it has been used this technique to fabricate sensors [1,3], supercapacitors [2,3,4], flexible memories [2,4], conformable Electro-Magnetic interference Shielding (EMI) layers [3] and to increase fabrics conductance for fabrics for avionic applications. In the first case we fabricated gas sensors using carbon nanotubes (CNTs) based transistors with and extremely high sensitivity (10ppb for NO2) at ambient air [1,3]. After that, we exploited the nanostructuration of mixtures of graphene and CNTs to achieve electrodes for supercapacitors. Spraying these mixtures, we built up sort of scaffolds that allow optimizing the exploitation of the surface of nanomaterials (using CNTs to avoid graphene layer restacking), the creation of a mesoporous distribution inside electrodes to increase power and, in case of pseudo-capacitance to make easier the electrodeposition of metal oxide (MnO2) inside the electrode [5]. The use of high quality graphene (<5 layers) and CNTs, with a diameter of around 20nm, also improve the conductivity for the electrodes and allowed us obtaining an impressive specific power value of around 100kW/Kg using an up-scalable industrially suitable fabrication technique [6-7-8]. The spray-gun deposition method has been also implemented in the fabrication of graphene oxide (GO) and carbon nanofibers based memories (ReRAM) [2,9]. In this case we case spray nanomaterials in water based suspensions on a flexible layer previously metallized. The total thickness is around 100nm. After contacting the top with metallic contacts creating pads, we are able to achieve flexible nonvolatile memories simply applying a bias (<3V). These memories show bipolar behavior and have been cycled 10000 times [3,9] without significant changes between on and off states. They constitute one of the first examples of information storage devices that can be fabricated using a roll-to-roll implementable method on flexible substrate. Finally, we have achieved EMS architectures using nanostructuration of CNTs and graphene mixture between polymers layers in order to exploit the Maxwell-Wagner-Sillars effect to absorb X-band frequencies [3]. Thanks to this nanostructuration we are able to trap the charges in sort of micro-capacitors created in the layers. Up to now with layer of around 100µm on conformable film, we are able to enhance the reflection up to 99%. This is a real breakthrough considering that usually heavy metal based layers are used and that in this case extremely thin conformable layers can be obtained opening the route for new kinds of applications that can be implemented by roll-to-roll fabrication. The versatility of this technique (with thickness form 100nm to mm) will increase its impact on a large panel of applications reducing dramatically the production costs. The first supercapacitors industrially fabricated using roll-to-roll will be produced along this year for avionics applications and implemented also for IoT.

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