Industrial implementation for nanomaterials deposition using dynamic spray-gun method. A new way of conceiving the 2D materials “lego view”

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This contribution deals with the fabrication of devices based on graphene based nanomaterials using dynamic spray-gun deposition method implemented through roll-to-roll. We used this technique to fabricate sensors, supercapacitors [1], flexible memories [1] and conformable Electro-Magnetic Shielding (EMS) layers. In the first case we exploited the nanostructuration of mixtures of graphene and carbon nanotubes (CNTs) to achieve electrodes for supercapacitors. Indeed the CNTs (Multi-Walled Carbon Nanotubes that are metallic and so conductive) are used as sort of spacers to avoid the restacking of graphene. Thanks to that we can exploit the huge surface of graphene to store charges and at the same time we create channels between the layers allowing the rapid charge and discharge of the device. The use of high quality graphene (<5 layers) and MWCNTs, 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 industrially suitable technique and not only a lab based one [2-3]. To increase the energy storage we have used ionic liquid, which are more viscous, having larger charges. In this case as spacers we have used carbon nanofibers with larger diameters (10nm-100nm). The spray-gun deposition method has been also implemented in the fabrication of Graphene Oxide and Carbon Nanofibers Oxidized based memories. In this case we case spray nanomaterials water based suspensions on a flexible layer previously metallized. The total thickness is around 100nm. After contacting the top with metallic contacts we are able to achieve flexible non volatile memories simply applying a bias (<3V). These memories show bipolar behavior and have been cycled 10000 times. They constitute one of the first examples of information storage devices that can be fabricated using a roll-to-roll implementable method. These devices can open new horizons in the integration of memories for examples in RFID tags or in packages. Finally, we have achieved EMS architectures using nanostructuration of graphene, MWCNTs and carbon nanofibers between polymers layers in order to exploit the Maxwell-Wagner-Sillars effect to absorb X-band frequencies. Thanks to this nanostructuration we are able to trap the charges in sort of micro-capacitors created in the layers. This is a real breakthrough considering that usually heavy metal based layers are used and that in this case mm based conformable layers can be obtained opening the route for new kinds of applications. Also in this case the fabrication will be implemented by roll-to-roll fabrication. During the presentation we will show all the details on the first characterization of devices and we will show also perspectives for other potential field of applications.

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