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Spray-gun deposition method for nanomaterials and its application in different high-impact field

Paolo Bondavalli

Thales Research and Technology, France

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 supercapacitors, flexible memories and conformable electro-magnetic shielding (EMS) layers. In the first case we exploited the nanostructuration mixtures of graphene and carbon nanotubes to achieve electrodes for supercapacitors (Fig.1). Indeed the carbon nanotubes (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 20 nm also improve the conductivity for the electrodes and allows us in obtaining an impressive specific power value of around 100 kW/kg using an industrially suitable technique not only a lab based one. In order to increase the energy storage we have used ionic liquid which are more viscous, having large charges. In this case as spacers we have used carbon nanofibers with larger diameters (10 nm -100 nm). The spray-gun deposition method has also been implemented in the fabrication of graphene oxide and carbon nanofibers oxidized based memories. In this case we spray nanomaterial water based suspensions on a flexible layer which are previously metallized. The total thickness is around 100 nm. After contacting the top with metallic contacts we are able to achieve flexible non-volatile memories by simply applying a bias (<3V). These memories show bipolar behavior and have been cycled 10000 times (Fig. 2). 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 example in RFID tags or in packages. Finally, we have achieved EMS architectures using nanostructuration of graphene, MWCNTs and carbon nanofibers between polymer layers in order to exploit the Maxwell-Wagner-Sillars effect to absorb X-band frequencies. Thanks to this nanostructuration as 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 also show perspectives for other potential fields of applications.

Recent Publications

1. P Bondavalli, C Delfaure, P Legagneux and D Pribat (2013) Supercapacitor electrode based on mixtures of graphite and carbon nanotubes deposited using a new dynamic air-brush deposition technique. Journal of The Electrochemical Society 60(4):A1-A6.
2. P Bondavalli, D Pribat, C Delfaure, P Legagneux, L Baraton, L Gorintin and J P Schnell (2012) Non-faradic carbon nanotubes based supercapacitors:state of the art. Eur. Phys. J. Appl. Phys. 60:10401.

Biography

Paolo Bondavalli is incharge of the nanomaterial transverse topic at Thales Research and Technology. In the last years, he has been the first author of several scientific papers dealing with CNTFET based sensors, supercapacitors and several patents dealing with gas sensors, thermal management through CNTs, nanomaterials deposition, supercapacitors and memristors like structures. Presently, his work is focused on the development of new materials (e.g., graphene, CNTs and nanowires) for the new generation of electronics devices and for energy storage applications and memristors. 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, etc. During the last five years he also participated as coordinator in several EU projects (concerning MEMS, MOEMS, CNTs, graphene, spintronics) and ANR projects. He is involved in the Graphene Flagship initiative.

paolo.bondavalli@thalesgorup.com