Solution processing of graphene, related 2d crystals and hybrid structures for energy conversion and storage

Dr Francesco Bonaccorso

Istituto Italiano di Tecnologia, Graphene Labs, Via Morego 30, 16163 Genova, Italy

Email: francesco.bonaccorso@iit.it

Abstract

Technological progress is driven by developments in material science. Breakthroughs can happen when a new type of material or new combinations of known materials with different dimensionality and functionality are created. Graphene, because of its many superior materials properties, has the opportunity to enable new products.[1] Graphene is just the first of a new class of two dimensional (2d) crystals, derived from layered bulk crystals.[2] The assembly of such 2d crystals (heterostructures) will provide a rich toolset for the creation of new, customised materials.[1,2]

Energy conversion and storage are two of the grand challenges that our society is facing. New materials and processes[1] can improve the performance of existing devices or enable new ones[2,3,4,5] that are also environmentally benign. In this context, graphene and other 2d crystals are emerging as promising materials.[1-5] A key requirement for these applications is the development of industrial-scale, reliable, inexpensive production processes,[2] while providing a balance between ease of fabrication and final material quality with on-demand properties.

Solution-processing[2] offers a simple and cost-effective pathway to fabricate various 2d crystal-based energy devices, presenting huge integration flexibility compared to conventional methods. Here I will present an overview of graphene and other 2d crystals-based energy conversion and storage applications, starting from solution processing of the raw bulk materials,[2] the fabrication of large area electrodes[3] and their integration in the final devices.[6,7,8]

References

1. A. C. Ferrari, F. Bonaccorso, *et al.*, "*Scientific and technological roadmap for graphene, related two-dimensional crystals, and hybrid systems*" ***Nanoscale*** DOI: 10.1039/c4nr01600a (2014).
2. F. Bonaccorso, *et al.,* Production and processing of graphene and 2d crystals. ***Materials Today***, *15*, 564-589, (2012).
3. F. Bonaccorso, *et. al.*, Graphene photonics and optoelectronics, ***Nature Photonics*** *4,* 611-622, (2010).
4. F. Bonaccorso, Z. Sun, Solution processing of graphene, topological insulators and other 2d crystals for ultrafast photonics. ***Opt. Mater. Express*** 4, 63-78 (2014).
5. G. Fiori, F. Bonaccorso**,** *et al.,* Electronics based on two-dimensional materials. ***Nature Nanotech*** *9,* , 768-779, (2014).
6. F. Bonaccorso, *et. al.,* Graphene, related two-dimensional crystals, and hybrid systems for energy conversion and storage. ***Science***, 347, 1246501 (2015).
7. J. Hassoun, F. Bonaccorso**,** *et al.* An advanced lithium-ion battery based on a graphene anode and a lithium iron phosphate cathode ***Nano Lett***. 14, 4901-4906 (2014).
8. P Robaeys, F Bonaccorso, *et al.* Enhanced performance of polymer: fullerene bulk heterojunction solar cells upon graphene addition. ***Appl. Phys. Lett***. 105, 083306 (2014).