Contribution (Invited)

Supercapacitors based in 3D graphene foams

Fernando Calle[1,2*], J. Pedrós[1,2], A. Boscá[1,2], S. Ruiz-Gómez[3], L. Pérez[3], J. Martínez[1,4]

[1]Instituto de Sistemas Optoelectrónicos y Microtecnología, Universidad Politécnica de Madrid, Madrid, Spain
[2]Dpto. Ingeniería Electrónica, ETSI Telecomunicación, Universidad Politécnica de Madrid, Madrid, Spain
[3]Dpto. Física de Materiales, F. Ciencias Físicas, Universidad Complutense de Madrid, Madrid, Spain
[4]Dpto. Ciencia de Materiales, ETSI Caminos, Universidad Politécnica de Madrid, Madrid, Spain
[*]fernando.calle@upm.com

Graphene stands out by many different properties (electrical, optical, structural, mechanical, thermal, etc.), which combinations allow to improve device performance or enable new applications. Perhaps, energy storage by means of supercapacitors and batteries is the main short-term field in which graphene will be exploited.

Graphene can be prepared by several techniques. Chemical vapor deposition (CVD) using catalytic metal foils or films has demonstrated very good results for quality single or few-layer 2D graphene. Similarly, 3D graphene structures are grown by CVD on Cu or Ni metal foams or sponges, showing a high surface useful for supercapacitor electrodes. The graphene foam (GF) processing involves material growth, substrate removal and, eventually, functionalization. We are using plasma enhanced CVD to grow the graphene coating on a metal foam acting as a catalytic mesh. The coating thickness depends on the metal substrate and the growth conditions (gases ratio, growth time, etc.). A free-standing GF is obtained by wet etching the metal substrate. Finally, the GF may be functionalized by different techniques and materials (polymerisation, electrodeposition, sol-gel), either to modify the graphene properties and/or to provide robustness to the 3D structure.

In this work we will discuss several demonstrations of GF-based electrodes for supercapacitors, either by filling the GF with a hierarchical polymer nanostructure [1], or different oxides by electrodeposition [2] or sol-gel. GFs may also be exploited to enhance the properties of batteries and other energy applications, as well as in sensors, environment and biomedicine.

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References

[1] J. Pedrós, A. Boscá, J. Martínez, S. Ruiz, L. Pérez, V. Barranco, F. Calle, J. Power Sources **317**, 35-42 (2016) + supp. inf.

[2] S. Ruiz-Gómez, A. Boscá, L. Pérez, J. Pedrós, J. Martínez, A. Páez, F. Calle, Diamond and Related Materials **57**, 63-67 (2015).