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PII: S1359-835X(16)30355-4
DOI: http://dx.doi.org/10.1016/j.compositesa.2016.10.028
Reference: JCOMA 4465

To appear in: *Composites: Part A*

Received Date: 24 July 2016
Revised Date: 16 October 2016
Accepted Date: 27 October 2016

Please cite this article as: Meng, Q., Wu, H., Zhao, Z., Araby, S., Lu, S., Ma, J., Free-standing, flexible, electrically conductive epoxy/graphene composite films, *Composites: Part A* (2016), doi: http://dx.doi.org/10.1016/j.compositesa.2016.10.028

Free-standing, flexible, electrically conductive epoxy/graphene composite films

Qingshi Meng [1], Hao Wu [2], Zhiheng Zhao [2], Sherif Araby [2, 3], Shaowei Lu[1], Jun Ma [*1, 2]

[1]Faculty of Aerospace Engineering, Shenyang Aerospace University, Shenyang, 110136, China
[2]School of Engineering, University of South Australia, Mawson lakes, SA, 5095, Australia
[3]Department of Mechanical Engineering, Faculty of Engineering, Benha University, Egypt

Abstract: Cost-effective, solution-processable and high-quality nanomaterials have critical roles in the development of advanced polymer composite films which combine mechanical robustness with functional properties such as electrical conductivity for many applications. This study first fabricated 3 nm-thick graphene platelets (GnPs) which have an electrical conductivity of 1460 S/cm; each platelet may contain double or a few layers of graphene whose C/O ratio was measured as 13.2. We then developed epoxy/GnP composite films by a layer-by-layer method through two-step curing. A percolation threshold of electrical conductivity was observed at merely 0.6 vol% GnPs, and the composite electrical conductivity increased to 1298.7 S/cm at 20.0 vol%. The composite films were mechanically strong to be used as the cost-effective electrodes for flexible supercapacitors. Specific capacitance 50.1 F/g was recorded for the 15.0 vol% composite film by two-electrode configuration, in comparison with the specific capacitance 41 F/g for commercial multi-walled carbon nanotubes. More importantly, impressive capacitance was found at a high current density of 20 A/g, which is desired in practical applications. The film electrode demonstrated a capacitance retention rate of 94.7% through 20,000 cycles. At a bending angle of 90°, it exhibited a capacitance of 38.9 F/g at 100 mV•s.