Colloids and Surfaces A: Physicochem. Eng. Aspects 414 (2012) 352–358

Contents lists available at SciVerse ScienceDirect

Colloids and Surfaces A: Physicochemical and Engineering Aspects

journal homepage: www.elsevier.com/locate/colsurfa

Morphology control and thermal stability of binderless-graphene aerogels from graphite for energy storage applications

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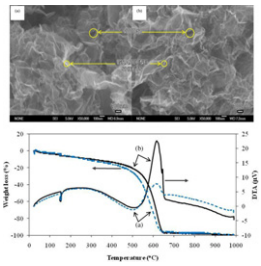
HIGHLIGHTS

- Graphene aerogel (GA) nanostructures synthesized from commercial graphite were controlled successfully.
- A hydrothermal method was used to synthesize GAs. No binders were used.
- Effects of fabrication conditions and graphene oxide concentration on the GA nanostructures were quantified.
- A maximum BET surface area of 394 m^2/g and the lightest density of 0.042 g/cm^3 were achieved.
- The GAs could be stable up to 500 °C in air.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 20 June 2012
Received in revised form 7 August 2012
Accepted 21 August 2012
Available online 28 August 2012

Keywords:
Graphene aerogel
Hydrothermal method
Controlled morphology
Energy storage applications
Binderless

ABSTRACT

Of all the challenges facing human beings in the near future, energy related issues are likely to be the grandest. To achieve a more sustainable society with adequate renewable energy and less environmental pollution, more versatile, robust and efficient approaches in electric energy storage and conversion are needed. To achieve these goals, the development of new electrode materials with high electrical conductivity, corrosion-resistance, high specific surface area, high porosity and low cost is highly desirable. Graphene aerogels (GAs) have been focused recently due to novel properties of graphene (extremely low electrical and thermal resistivity, large carrier mobility, high surface area and mechanical elasticity) and the low cost and easy preparation of graphene from graphite. The performance of GA-based electrodes strongly depends on the morphology and structure of the GAs. However, there has been little study on the optimization of the GA nanostructures in terms of surface area, pore size, pore volume and density for energy storage devices. In this work, the GA nanostructures synthesized from commercial graphite were controlled successfully. The graphene oxide (GO) was prepared from commercial graphite powder using a modified Hummers method. A hydrothermal method was used to synthesize GAs due to its simplicity, environmental friendliness and low cost. No binders were used to prevent their negative effects to the electrical conductivity of the aerogels. Effects of fabrication conditions and the GO concentration on the GA nanostructures were also quantified. A maximum Brunauer–Emmett–Teller (BET) surface area of 394 m^2/g and the lightest density of 0.042 g/cm^3 were achieved when the GA with 3 mg GO/mL was hydrothermally treated at 180 °C for 1.5 h. The thermal durability analysis showed that the GAs could

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0927-7757/$ – see front matter.
http://dx.doi.org/10.1016/j.colsurfa.2012.08.048