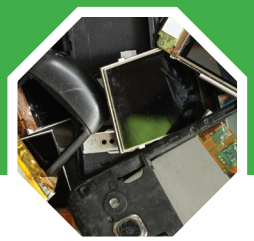
WasteEng 18

7th International Conference on Engineering for Waste and Biomass Valorisation



July 2-5, 2018

Prague, Czech Republic

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The 7th International Conference on Engineering for Waste and Biomass Valorisation (WasteEng2018)

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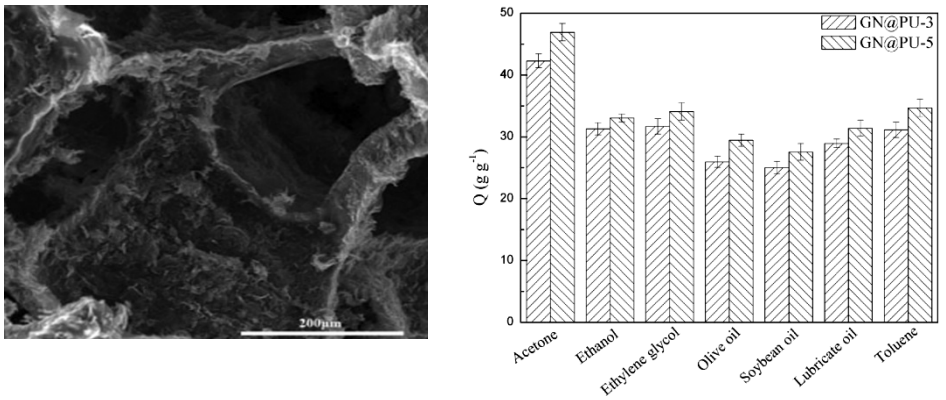
GRAPHENE SPONGES FOR OIL REMOVAL

GEORGE Z. KYZAS[1], ATHANASIOS C. MITROPOULOS

[1] *Hephaestus Advanced Laboratory, Eastern Macedonia and Thrace Institute of Technology, Kavala, GR-654 04, Greece.*

Abstract

Many different types of materials have been proposed or tested for use in cleaning up oil spills, including zeolites, polymers, activated carbon, and even sawdust. Selective absorption capacity of the oil layer is of paramount importance in such an application, and the toxicity of the absorbent itself is also an important consideration. Based on our research, some graphene-sponges were in order to achieve a morphology with a high surface area. Briefly, the fabrication of GN@PU (graphene/polyurethane) sponge was achieved via a simple dip-coating method. The raw PU (polyurethane) sponge with dimensions of 40×40×20 mm^3 was washed respectively with the ethanol and deionized water to remove impurities of the sponge. Different mass ratios of GN (1 g) to CNWs that was 1:5 (GN@PU-1), 1:10 (GN@PU-2), 1:20 (GN@PU-3) and 1:30 (GN@PU-4) were fabricated, respectively. The mixture of GN and CNWs was dispersed in deionized water (400 mL) with the assistance of ultrasonication for 36 h. Then the sponge was put into the disperse solution followed by ultrasonication for 40 min. 4 samples were prepared for each dip coating process. The dip-coated sponges were taken out and put in the oven for drying for 24 h at 50°C. After that, the process of both dip-coating and drying was repeated once to make sure the GN was uniformly coated on the PU sponge surface. In order to eliminate the effect of hydrophilic CNWs (cellulose nanowhiskers) on the wetting behavior of sponges, GN@PU-5 was selected to be dip coated firstly in GN/CNWs suspension (CNWs/GN = 1:20) and drying for 24 h at 50°C. Then the dried sponge was put into pure GN suspension and dried. Thus the outer surface layer is only covered with neat GN sheets without CNWs. This sponge was named GN@PU-5. GN@PU-6 sponge was fabricated by putting PU sponge in pure GN suspension and drying, this process was repeated to compare with other sponges. All dip-coating process was lasted 40 min following ultrasonication and drying processes were continued for 24 h at 50 °C.



(a) (b)

Fig. 1. (a) SEM images of the morphology of GN@PU-6 (b); the exterior of GN@PU-6 (b) Absorption capacity of GN@PU (1:20) sponge for various oils and organic solvents.

The GN@PU-3 sponge (the mass ratio of CNWS to GN was 1:20) was optimum ratio for the oil absorption. GN@PU sponges were fabricated with a simple dip-coating method, where PU sponges functioned as a basic continuous framework. The GN@PU sponges can be continuously conducted the experiment of oil-water separation more than 100 cycles. The GN@PU sponges can effectively separate oils and organic solvents in water, and absorption capacity of lubricating oil was 28 g/g. Moreover, according to thermal and mechanical analysis, the GN@PU sponges exhibited excellent elasticity of PU sponge and good thermal and chemical stability. Furthermore, even conducting oil-water separation experiment 50 times, GN@PU-5 still kept super-hydrophobicity with water contact angle over 150°. It exhibited excellent performance with adsorption capacity for toluene, acetone, and lubricating oil of 34, 46, and 31 g/g, respectively. In conclusion, the GN@PU sponges were fabricated with dip-coating method, which simplified the process of preparation and saved production cost. And the GN@PU sponges possessed excellent functional performance and a broad application future due to excellent oil-water separation capacity and notable cycle performance.

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[1] Luo, Y., Jiang, S., Xiao, Q., Chen, C., Li, B.: Highly reusable and superhydrophobic spongy graphene aerogels for efficient oil/water separation. Sci. Rep. 7, (2017)

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[3] Ao, C., Yuan, W., Zhao, J., He, X., Zhang, X., Li, Q., Xia, T., Zhang, W., Lu, C.: Superhydrophilic graphene oxide@electrospun cellulose nanofiber hybrid membrane for high-efficiency oil/water separation. Carbohyd. Polym. 175, 216-222 (2017).)

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Paper description:

Number: **224**

Title: **Graphene sponges for oil removal**

Authors: **KYZAS George - MITROPOULOS Athanasios**

Type: **Poster standard**

Dear **George KYZAS**,

Your paper mentioned above has been accepted for **Poster standard** presentation at the WasteEng2018 Conference. This conference will be held in Prague, Czech Republic, from July 2-5, 2018.

This unique event will address major issues related to Biomass and Waste Valorisation as well as the Life Cycle Assessment approaches and will benefit from the full participation of all players concerned at the international level. New technologies for processing biomass and wastes and the most recent results on environmental impact assessment methods, risk evaluation and reuse scenarios will be presented. This meeting will be an opportunity to foresee new scientific, industrial and legislative developments.

500 presentations (keynote lectures, oral and poster presentations) from 61 countries will be given at this conference. WasteEng2018 Conference will bring together representatives from industry, academia, governments and other sectors related to Chemical Engineering, Civil Engineering and Environmental Engineering.

You may also participate to the panel discussions that will be organised at the conference. They will aim to identify and summarize the main ideas from the conference and draw the future trends in the field.

I look forward to welcoming you in Prague at this occasion.

Yours sincerely,

Pr Ange Nzihou
Chair of the Organising Committee, WasteEng2018
Editor-in-Chief Waste and Biomass Valorization

Graphene sponges for oil removal

George Z. Kyzas, Athanasios C. Mitropoulos

Hephaestus Advanced Laboratory, Eastern Macedonia and Thrace Institute of Technology, Kavala GR-654 04, Greece

Aim - Novelty

- ✓ Many types of materials have been proposed or tested for use in **cleaning up oil spills**, including zeolites, polymers, activated carbon, and even sawdust.
- ✓ **Selective absorption** capacity of the oil layer is of paramount importance in such an application, and the toxicity of the absorbent itself is also an important consideration.
- ✓ Some **graphene-sponges** were in order to achieve a morphology with a high surface area.

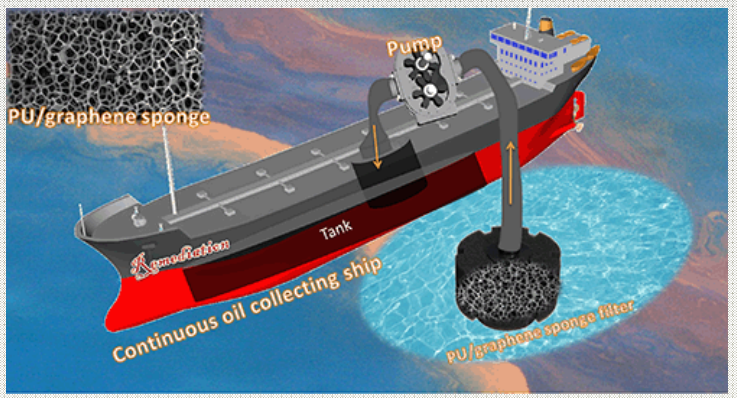
Extended synthesis procedure

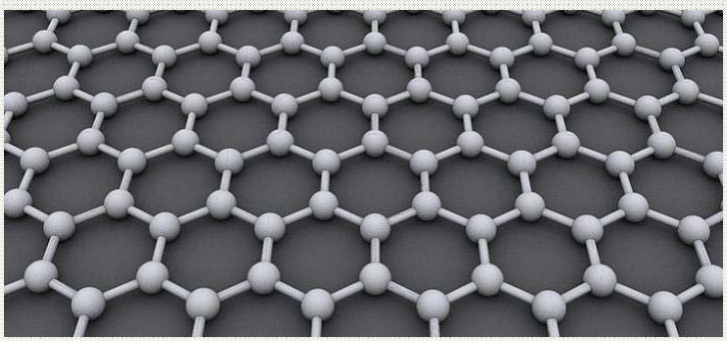
The fabrication of GN@PU (graphene/polyurethane) sponge was achieved via a simple dip-coating method.

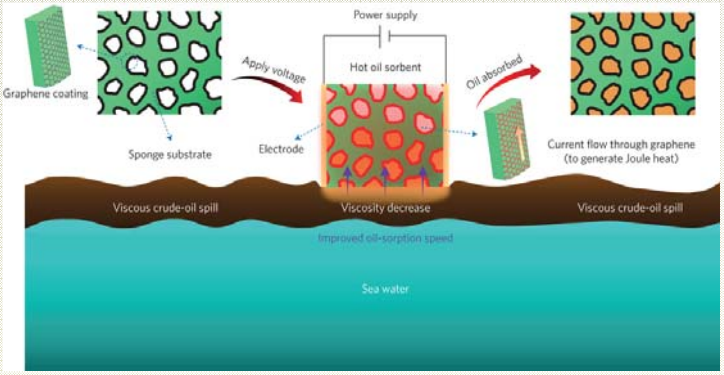
- ➢ The raw PU (polyurethane) sponge with dimensions of 40×40×20 mm^3 was washed respectively with the ethanol and deionized water to remove impurities of the sponge.
- ➢ Different mass ratios of GN (1 g) to CNWs that was 1:5 (GN@PU-1), 1:10 (GN@PU-2), 1:20 (GN@PU-3) and 1:30 (GN@PU-4) were fabricated, respectively.
- ➢ The mixture of GN and CNWs was dispersed in deionized water (400 mL) with the assistance of ultrasonication for 36 h. Then the sponge was put into the disperse solution followed by ultrasonication for 40 min. 4 samples were prepared for each dip coating process.
- ➢ The dip-coated sponges were taken out and put in the oven for drying for 24 h at 50°C.
- ➢ After that, the process of both dip-coating and drying was repeated once to make sure the GN was uniformly coated on the PU sponge surface.
- ➢ In order to eliminate the effect of hydrophilic CNWs (cellulose nanowhiskers) on the wetting behavior of sponges, GN@PU-5 was selected to be dip coated firstly in GN/CNWs suspension (CNWs/GN = 1:20) and drying for 24 h at 50°C.
- ➢ Then the dried sponge was put into pure GN suspension and dried. Thus the outer surface layer is only covered with neat GN sheets without CNWs.
- ➢ This sponge was named GN@PU-5. GN@PU-6 sponge was fabricated by putting PU sponge in pure GN suspension and drying, this process was repeated to compare with other sponges. All dip-coating process was lasted 40 min following ultrasonication and drying processes were continued for 24 h at 50 °C.

Appl. Surf. Sci. 422 (2017) 116-124

Potential applications







Characterizations

- ❖ The GN@PU-3 sponge (the mass ratio of CNWS to GN was 1:20) was optimum ratio for the oil absorption. GN@PU sponges were fabricated with a simple dip-coating method, where PU sponges functioned as a basic continuous framework.
- ❖ The GN@PU sponges can be continuously conducted the experiment of oil-water separation more than 100 cycles. The GN@PU sponges can effectively separate oils and organic solvents in water, and absorption capacity of lubricating oil was 28 g/g.
- ❖ According to thermal and mechanical analysis, the GN@PU sponges exhibited excellent elasticity of PU sponge and good thermal and chemical stability.
- ❖ Even conducting oil-water separation experiment 50 times, GN@PU-5 still kept super-hydrophobicity with water contact angle over 150°. It exhibited excellent performance with adsorption capacity for toluene, acetone, and lubricating oil of 34, 46, and 31 g/g, respectively. In conclusion, the GN@PU sponges were fabricated with dip-coating method, which simplified the process of preparation and saved production cost. And the GN@PU sponges possessed excellent functional performance and a broad application future due to excellent oil-water separation capacity and notable cycle performance.

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Acknowledgment

The project "Multifunctional super-adsorbent materials for efficient decontamination of oil spills and heavy metal effluents" supported by Stavros Niarchos Foundation is acknowledged for the funding of this work.