Fabrication of Graphene Fiber Fabrics as Sorbents for Radioactive Iodine Gas

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1. Introduction

During a reprocessing of spent fuels, significant amount of ^{129}I are exposed into a gas stream of the facility. Since ^{129}I can affect to environment and human health, it has to be removed before release the gas. Various radioactive iodine adsorbents have been developed by impregnating silver in porous support such Ag-zeolites or Ag-silicate due to the chemical affinity of Ag for iodine [1]. Recently, graphene-based materials such as graphene-powder or graphene-aerogel have been studied for iodine sorbents, and they showed high physisorption properties for iodine gas [2]. In this study, we prepared graphene fiber fabrics for real application of iodine removal. Because fiber-form does not be compacted as powder-form, there is low pressure drop. Also, fiber has thin shape and high permeability of gas flow, adsorption kinetics are faster than granular-form [3].

2. Experiment

2.1 Preparation of graphene oxide (GO) solutions

Graphite intercalated compounds prepared from reaction of graphite flake and small quantity of sulfuric acid and oxidizing agent. After that, expanded graphite were prepared by microwave-assist expansion. Graphene oxide (GO) solution was synthesized by the modified Hummer's methods from the expanded graphite. Finally, the GO solution was washed and concentrated with centrifuge.

2.2 Preparation of graphene fibers fabrics

The graphene fiber fabrics were prepared as following the procedure [4]. The graphene oxide solution was doped on a syringe pump and injected at the flow rate of 50 μL/min into a fast-rotating (50 rpm) coagulation bath. The coagulation bath contained 5wt.% of $CaCl_2$ aqueous solution. Then as-spun graphene oxide fibers were broken by the fast rotating, and short fibers were collected in the bath. The short fibers were washed with water and collected by vacuum filtering. After drying the short fibers in vacuum oven at 60°C for a day, they were re-dispersed in mixture of water and ethanol in a ratio of 50:50 (v/v). The dispersed short fibers were collected with vacuum filtering again and dried in vacuum oven at 80°C for a day. Then the short fibers were inter-connected by rapid swallowing and drying of gel-state fibers which called "wet-fusing". Finally, the graphene oxide fiber fabrics were chemically reduced with HI at 80°C for 12 h.

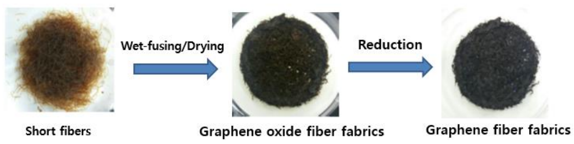

Fig. 1. Fabrication process of graphene fiber fabrics.

3. Results and discussions

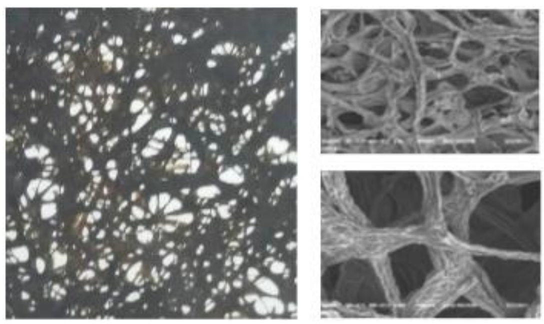

Fig. 2. The morphologies (left) and SEM image (right) of graphene fiber fabrics.

Since the graphene fiber fabrics were fabricated from short fibers as building blocks, they have a large empty space which can accept a high flow rate of fluids. The random orientation of short fibers was due to the process of re-dispersion. The random orientation has advantages of direction-independent properties such as mechanical strength or electrical conductivity. Also, the fibers were connected strongly without binders such as resin and lots of the junction points make the fabrics resistive for fractures.

4. Conclusion

At this study, the graphene fiber fabrics were fabricated with wet-fusing method for effective removal of radioactive iodine gas. The fabrics had a randomly oriented and strong bonded of short fibers structures which have advantages of purification of flowing gas. For the future work, the characteristic of flow resistance and iodine adsorption will be investigated.

Reference

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