Development of Silver-Graphene Fiber Composites as Sorbents for Radioactive Iodine Gas

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1. Introduction

There has been a lot of effort to remove ^{129}I from the gas streams of reprocessing facilities to protect the environment and human health from the radiographic exposure. Therefore, various methods, such as wet scrubbing or solid sorbents, have been suggested to capture iodine. Due to the simplicity of designing the removal systems, solids sorbents are more preferred than other methods. Silver (Ag) impregnated solid sorbents, such as Ag-zeolites or Ag-silicate, have been developed especially because of the chemisorption properties of Ag for iodine [1]. Recently, graphene-based materials have been studied as potential iodine sorbents. They showed better performance than other conventional iodine sorbents in the laboratory scale [2]. In this work, composites of graphene fiber [3] hybridized with silver as sorbents have been prepared for the effective removal of iodine gas. By preparing the fiber-type adsorbent, it is expected that the pressure drop of gas streams will be lower than powder-type sorbents and the adsorption kinetics will be faster than granular-type adsorbents [4].

2. Preparation

2.1 Preparation of graphene oxide (GO)

Expanded graphite was first prepared by the microwave irradiation (720W, 2.45 GHz) of graphite intercalated compounds. After that, GO solution was synthesized by oxidizing the expanded graphite using Kovtyukhova's method and Hummers's method.

2.2 Preparation of graphene fibers

To obtain the GO liquid crystals, the prepared GO solution was concentrated by centrifuge. And then, the GO solution was placed in the syringe and injected into a rotating coagulation bath. The coagulation bath contained the $CaCl_2$ aqueous solution. The GO solution was coagulated and formed a gel-state fiber. The gel fiber was stretched and suspended on a pair of spaced parallel sticks. The GO fiber can be obtained by drying the gel fiber at air for 1 day and at vacuum oven for 12 hours. The prepared GO fiber was chemically reduced by hydroiodic acid at 80 ^{o}C for 12 hours. After that, the reduced GO fiber was dried at a vacuum oven for 1 day.

2.3 Hybridization with silver

The silver-graphene composites were fabricated by electroplating methods. The reduced graphene fiber was soaked in a silver nitrate solution with metallic silver. Then, a voltage of at least 0.8V, which is the reduction potential of silver, was applied on the two ends of the fiber (Fig. 1).

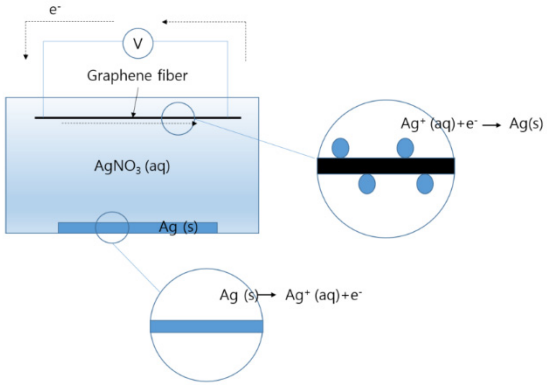

Fig. 1. The process of Ag-graphene fiber hybridization.

3. Results and Discussions

Fig. 2 and Fig. 3 show the morphologies of the silver-graphene fiber composite. Since the large-size graphene oxide plates were shrunk into small-diameter cylinder-like shape fibers, the surface of the fiber has a lot of wrinkles that enhance the surface

area. In addition, numerous defects on the graphene sheet can provide the space for the growth of silver nanocrystalline.

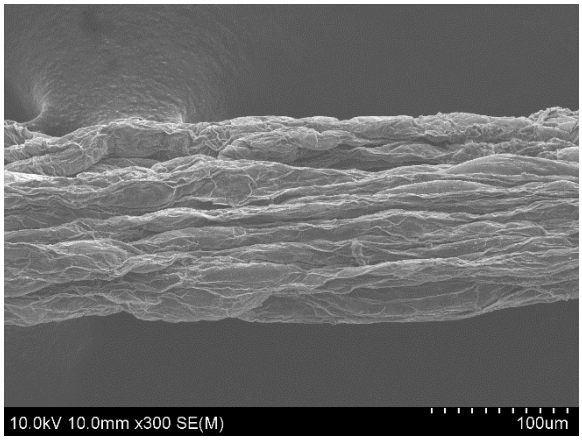

Fig. 2. SEM image of the Ag-graphene fiber.

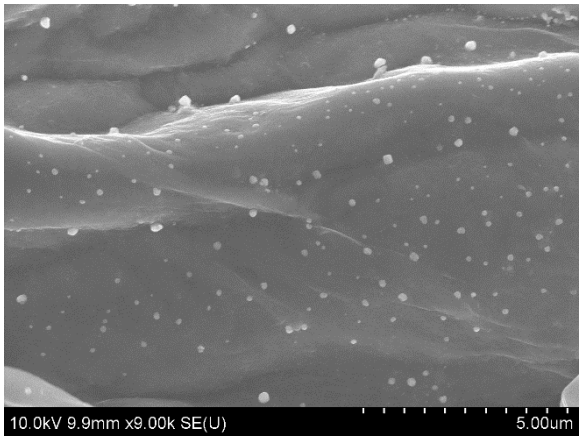

Fig. 3. Nano-sized silver particles attached on the graphene fiber.

4. Conclusion

In this paper, the silver-hybridized graphene fiber composites were synthesized to be used in radioactive iodine gas removal. The electrodeposition method showed evenly deposited silver nanocrystalline on the surface of the graphene fiber. For the future work, the composites will be characterized using various analysis techniques such as EDS, XRD, or XPS. Based on the results, the hybridization process conditions will be optimized. Lastly, the iodine sorption kinetics and the gas permeability of the composite sorbents will be estimated.

Acknowledgement

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