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Fabrication of Mxene-based fabrics for Radioactive Cs Removal

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1. Introduction

Radioactive Cs is the one of major fission product of U-235, especially Cs-137 is the most troublesome isotopes due to high activity and long-term half-life. Since Cs has similar biochemical behaviors with potassium, it can be harmful for human body. For removing Cs from ground water or sea water around nuclear accident sites or decomissing sites, zeolite, Prussian blue[1], or crown ether-based ion-exchange[2] materials have been developed.

Electrochemical switched ion exchange (ESIX) methods also have considered for overcoming limitation of conventional physico-chemical based ion-exchange materials. By applying electrical potential, ions can be fastely migrated in ion-exchange media, and ion-exchange capacity is enhanced due to change of oxidation states[3,4]. Typically, metal-hexacyanoferrates (MHCFs)-based electrode materials are used for EXIS but MHCF has low electrical conductivity and low chemical stability[3]. Semi-conduct materials such as bismuth oxychloride (BiOCl) also have been developed, but it is hard to get large crystallites so that it cannot be used without any support materials[4].

Recentely, MXene ($Ti_3C_2T_x$) is extensively researched for electrochemical application due to it hydrophilic and electrochemical conductivity[5]. Also, MXene has good properties for selective Cs ion-exchange materials. Since the marrits of MXene, we have fabricated MXene-based fabric materials for EXIS electrode applications.

2. Methods and Results

2.1. Fabrication of MXene

MXene and its precursor, MAX, were fabricated by following methods[6]. First, MAX was prepared by heat treated at 1380 °C for 6hr after ball milling of mixed powder (TiC:Ti:Al) in 2:1:1 atomic ratio. After then, MXene was synthesized MILD (Minimum Intensive Layer Delamination). In 20 ml of HCl (9M), 1g of MAX and 1.6 g of LiF were stirrered at 25 °C for 24hr. Finally, synthesized MXene was washing with centrifuge.

2.2 Fabrication of MXene-based Fabrics

MXene-based fabric materials were fabricated by wet-spinning with acidic gelation methods[7]. After wet-spinning for few hours, the fibers were washed, collected in filter furnel, and dried in vacuum oven overnight.

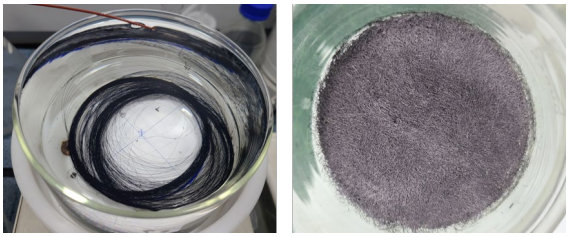

Fig. 1. Wet-spinning process and MXene-based fabrics

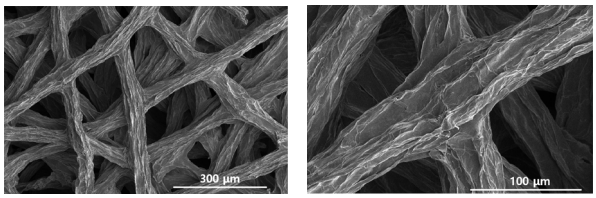

Fig. 2. Microstruture of MXene-based fabrics

3. Conclusion

MXene-based fabrics were fabricated for radioactive Cs due to the electrochemically desired and selective Cs ion-exchange characteristics of MXene. In future work, hydraulic permeability and mechanical properties characterization will be conducted for real application. Also, Cs sorption mechanism will be researched with three-electrodes cyclic voltammetry experiment in Cs aqeous solutions.

Acknowledgement

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