

# Fabrication of MXene Fiber-based Fabrics for Radioactive Cs Removal

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## OBJECTIVES OF THE STUDY

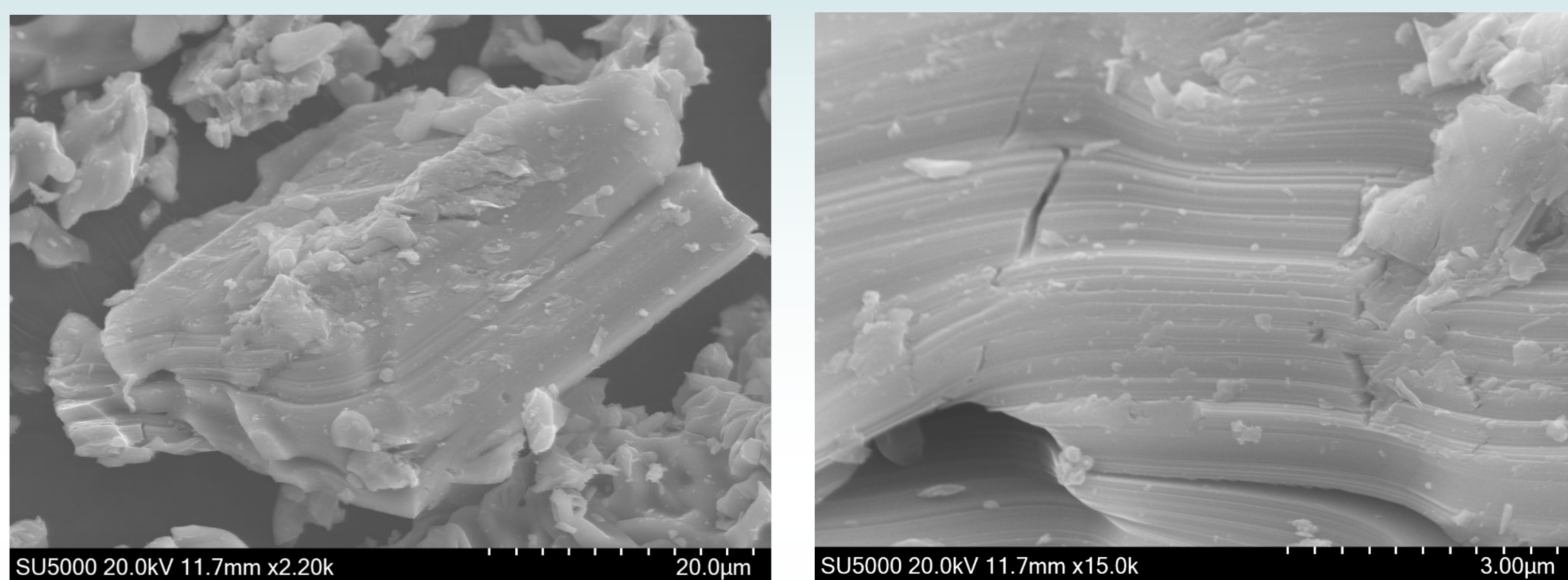
- Development of MXene fiber-based fabrics for electrochemical Cs sorption electrode.

### Introduction

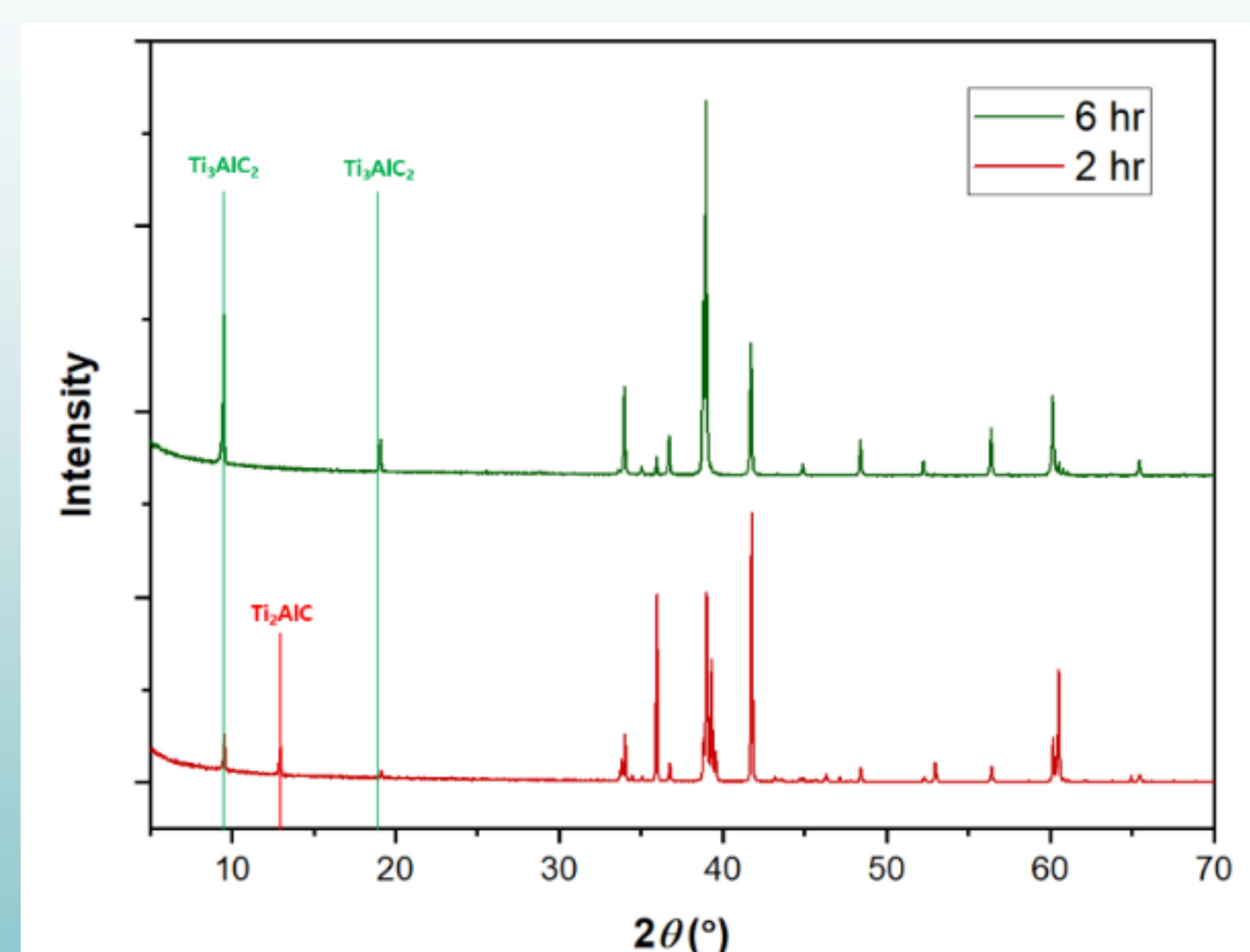
- Radioactive Cs is the one of major fission products of U-235, especially Cs-137 is the most troublesome isotopes due to high activity and long-term half-life.
- Since Cs has similar biochemical behaviors with potassium, it can be harmful for human body.
- Electrochemical switched ion exchange (ESIX) methods also have considered for overcoming limitations of conventional physicochemical based ion-exchange materials such as zeolite.
- MXene ( $Ti_3C_2T_x$ ) is extensively researched for electrochemical application due to its hydrophilic and electrochemical conductivity.
- MXene has good properties of selective Cs ion-exchange materials.
- MXene should be fabricated with appropriate 3D structure for real applications, and we have chosen a non-woven fabric structure for minimizing flow resistance.

### Preparation of $Ti_3AlC_2$

- TiC, Ti, and Al powders were mixed in a 2:1:1 molar ratio, ball milled for 18 hours.
- The mixed powder was annealed at 1380 °C for 6 hours. Not enough annealing time would produce  $Ti_2C$  impurity.
- Synthesized MAX was crushed and sieved with 200 mesh screen
- The MAX powder had a layered microstructure and they were used for synthesizing MXene.



Scanning electron microscopic image of  $Ti_3AlC_2$



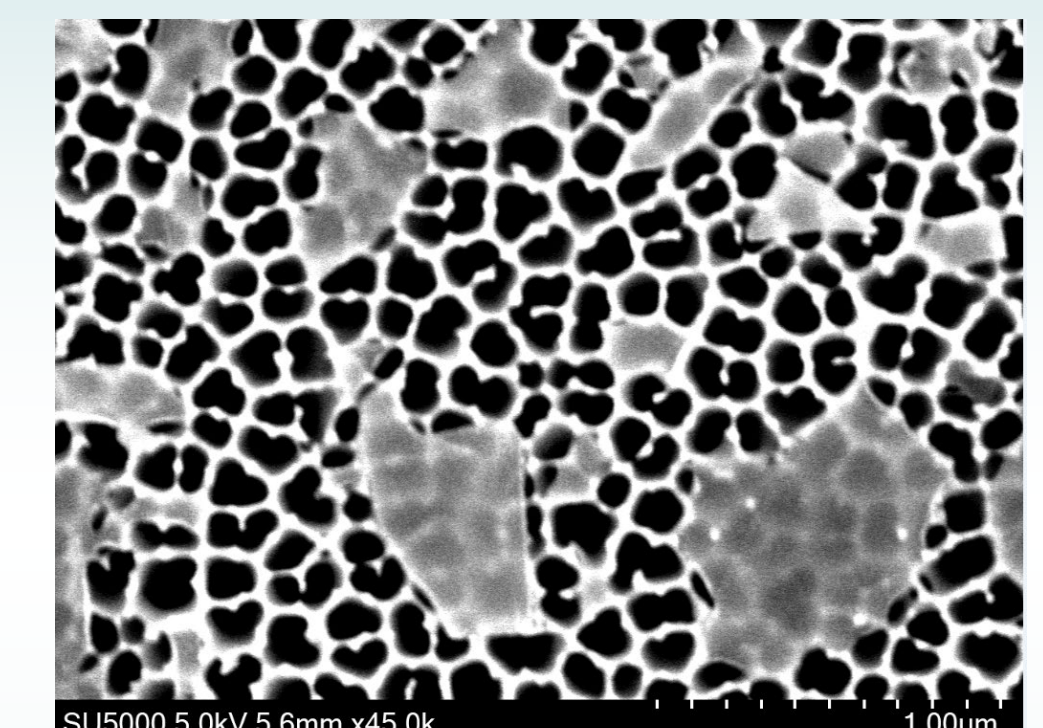
XRD analysis of  $Ti_3AlC_2$

### Preparation of MXene solution

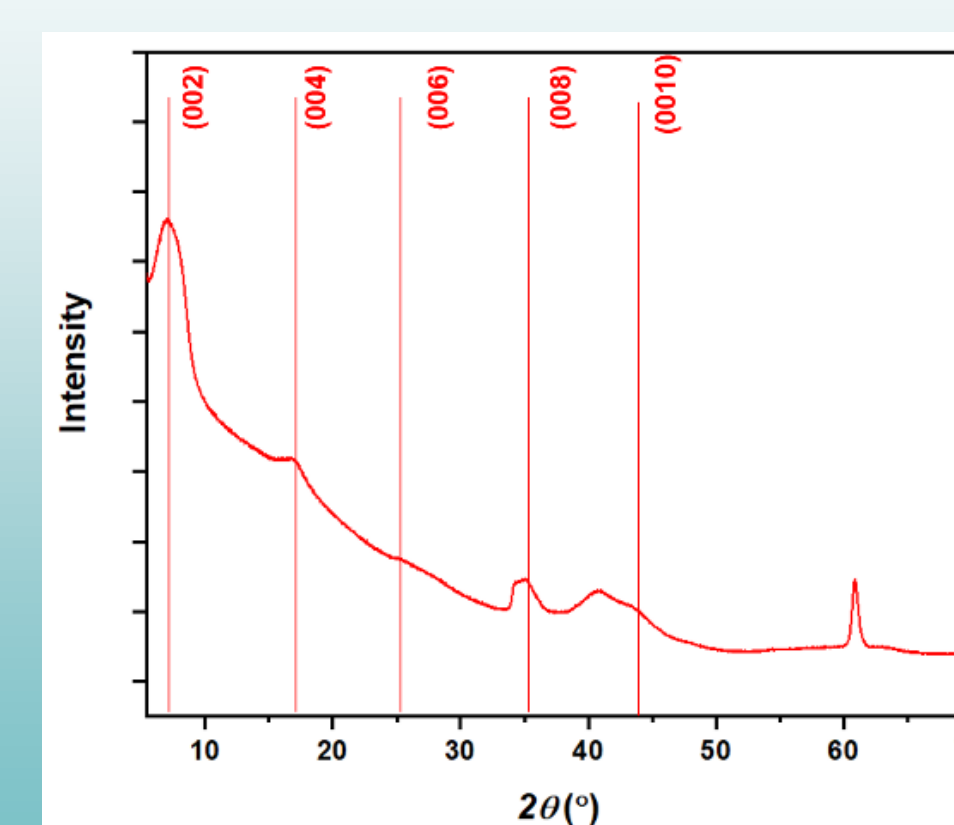
- $Ti_3C_2T_x$  MXene was synthesized with MILD methods
- After stirring 1.6 g of LiF in 20ml of HCl solution (9M), 1 g of MAX powder was added and stirring for 24 hours at room temperature.
- The reacted MAX was centrifuged and washed until the pH reached 6.
- After separating unetched MAX by centrifuging for 5 min, water dispersed MXene can be obtained.



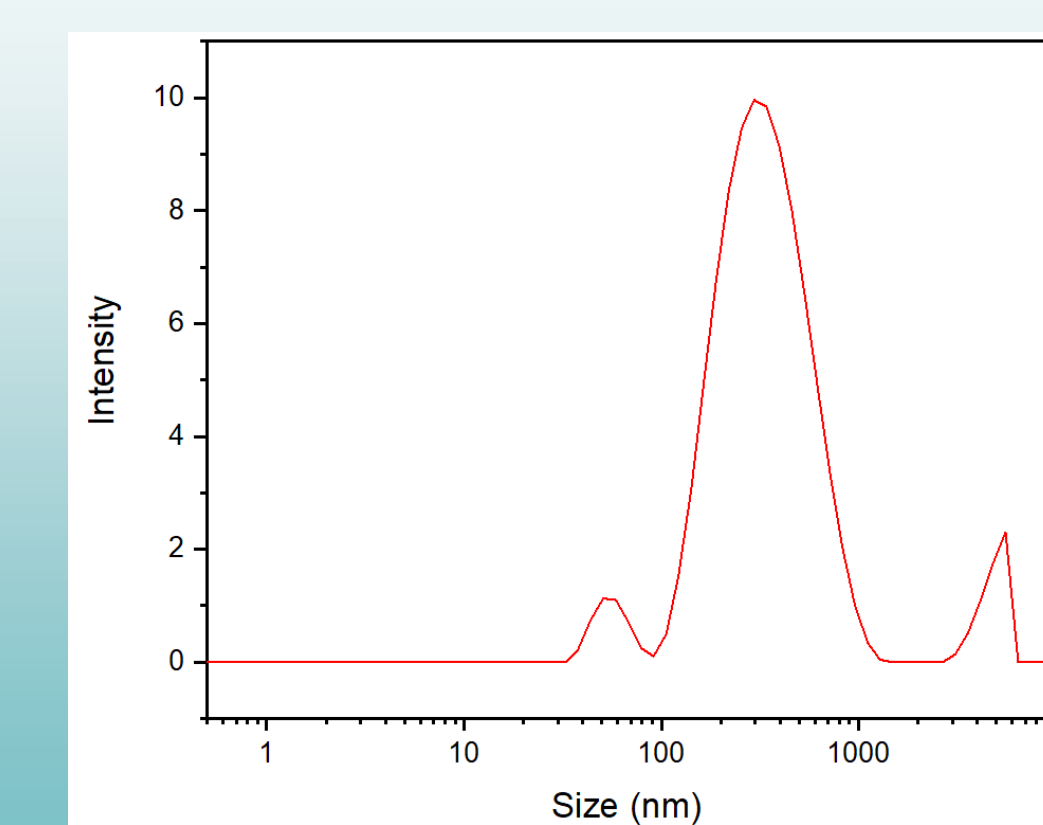
MXene solution (~1.5 mg/ml)



MXene flake on anodisc



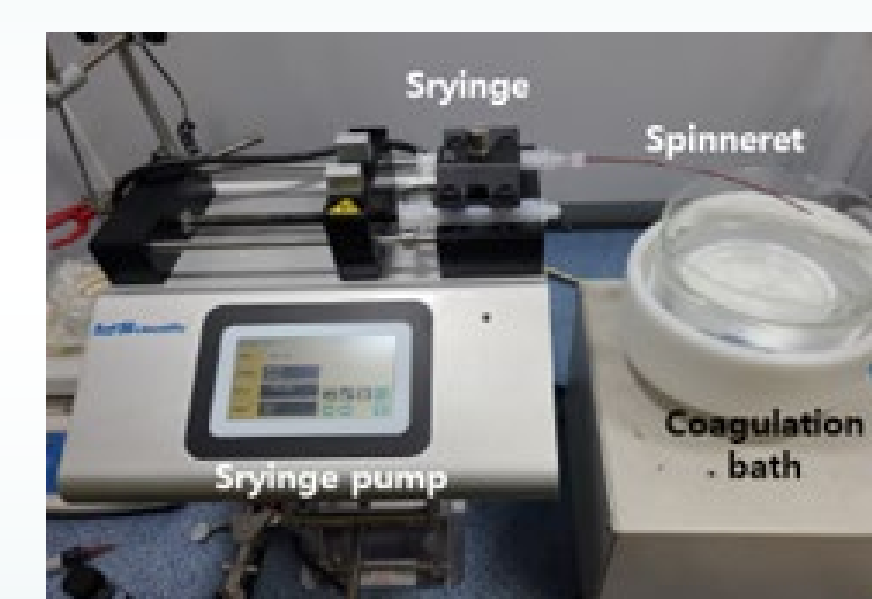
XRD pattern of MXene film



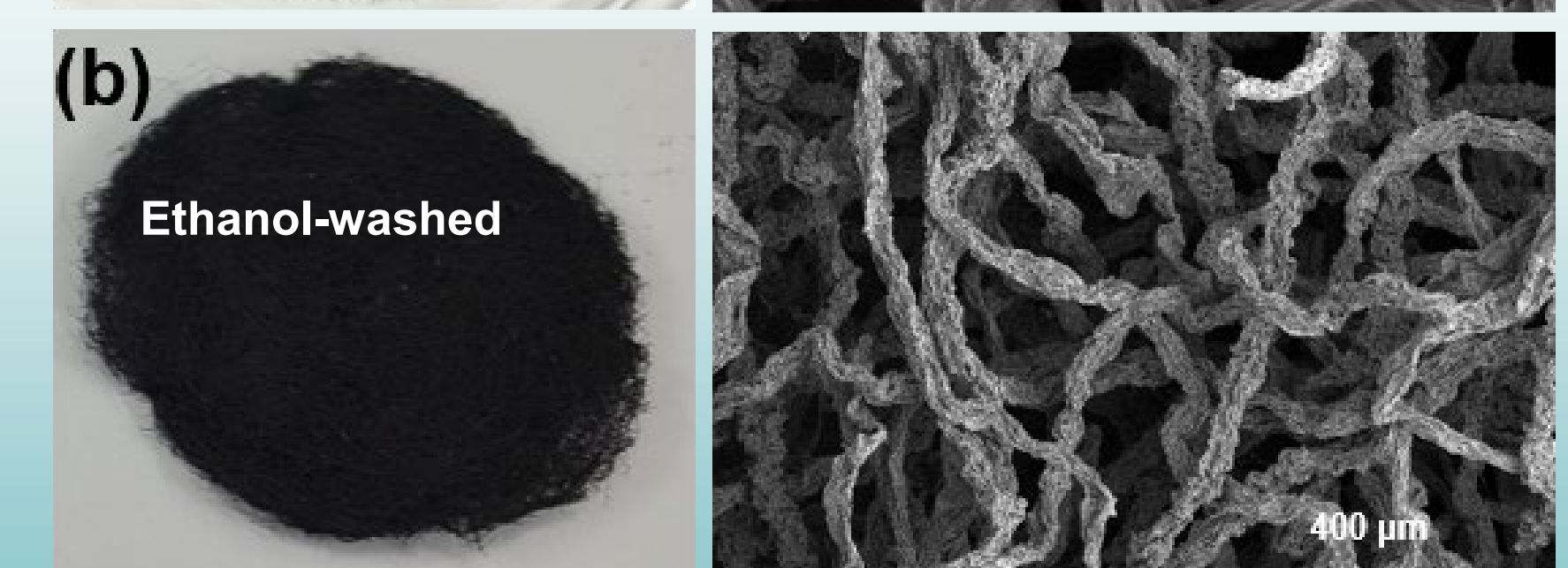
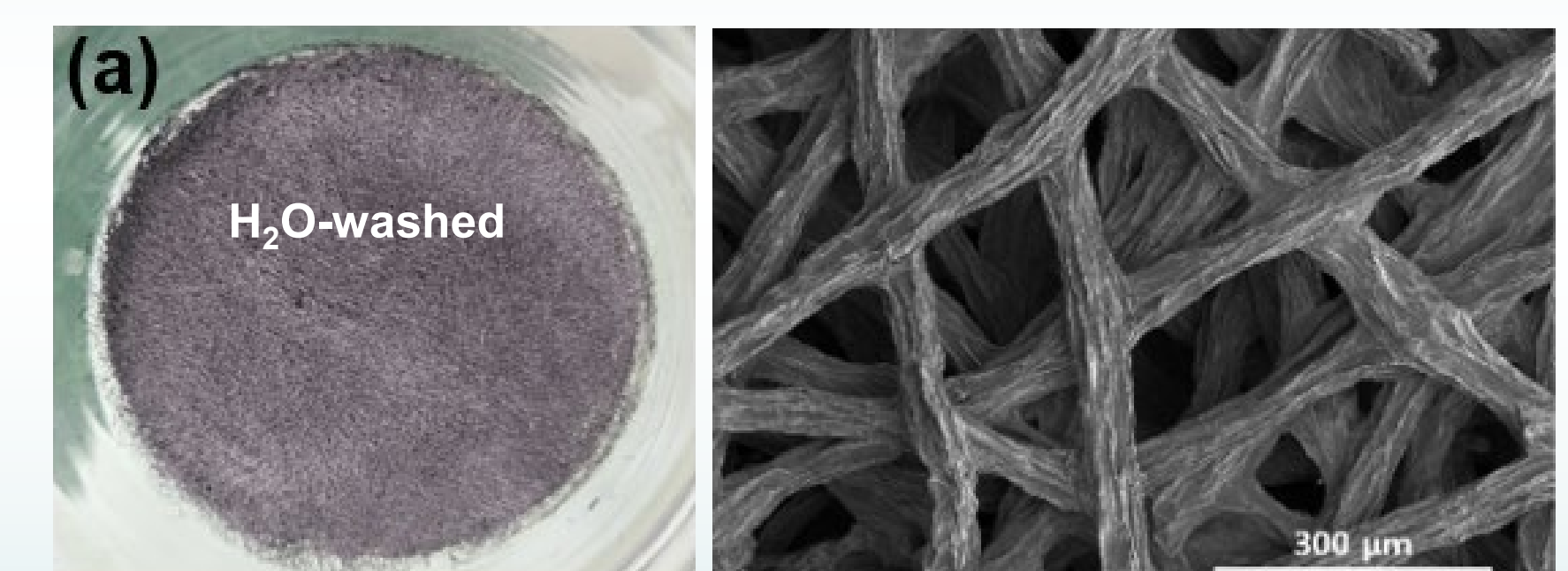
MXene flake size distribution (DLS)

### Fabrication of MXene fiber-based fabrics

- The MXene solution was further centrifuged until the concentration reached to 35mg/ml.
- The MXene solution was doped on the syringe and injected into a coagulation bath containing HCl.
- The long as-synthesized MXene gel fiber was washed, dispersed, filtered on porous alumina disc, and dried.
- During drying, inter-fusion between short fibers was formed, and they can be controlled by washing solvent.



Fiber spinning equipment



As-synthesized MXene fiber

MXene fiber-based fabrics and their microstructures

### Future work

- Optimization of inter-fiber fusing by controlling washing process
- Investigation of electrochemical behavior for Cs ion
- Static and dynamic Cs sorption test