

MXene–Carbon Nanotube Membranes for Electrochemical Energy Applications



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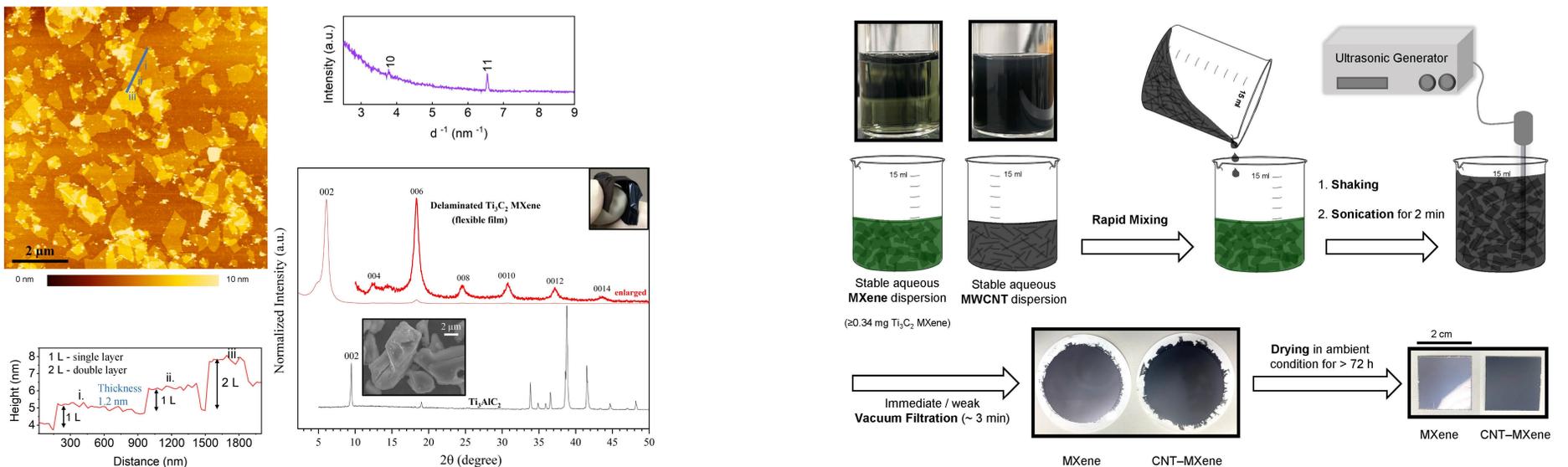
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Overview

- Superior prospect of 2D MXenes for electrochemical energy storage applications.
- Restacking and agglomeration of MXenes considerably limit their true potential for fast ion transport.
- CNTs were dispersed to control the structure and porosity of MXene membranes.
- CNT–MXene hybrid membranes show dramatically improved Li-ion transport properties.

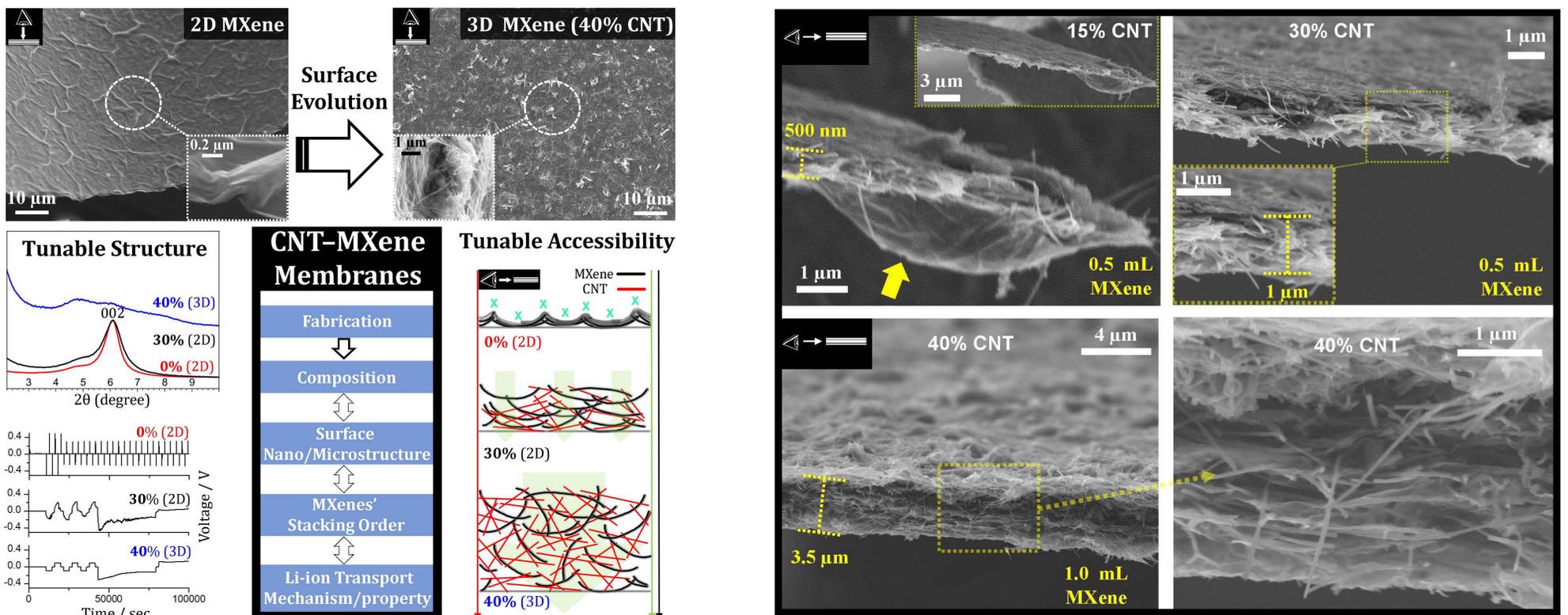
Method

- A scalable method to fabricate ultralight yet continuous CNT–MXene membranes with uniform/3D CNTs dispersion.



Structure and Li-ion Transport Mechanism

- Correlation among CNTs content, surface microstructure, MXenes' stacking structure & ion transport properties of the films.
- Li-ion transport mechanisms in the CNT–MXene membranes.
- MXene membranes with tunable 2D and 3D structures with improved ion-transport performances.



- The compact surface microstructure of MXene membranes is dramatically changed as CNTs occupy MXene/MXene edge interfaces.
- The 2D stacking order of MXenes is preserved up to 30 wt% CNTs.
- The 2D alignment is completely disrupted at 40 wt% CNTs, and a more pronounced surface opening and internal expansion of ~770% are realized.
- Both 30 wt% and 40 wt% membranes show stable cycling performance under a significantly higher current density due to faster transport channels.
- Notably, for the 3D 40 wt% membrane, over-potential during repeated Li deposition/dissolution reactions is further reduced by another ~50%.
- Ultralight yet continuous hybrid films comprising up to ~0.027 mg/cm² Ti₃C₂ MXene can be prepared using aqueous colloidal dispersions and vacuum filtration for specific applications.

Summary

- A method to fabricate ultralight yet continuous CNT–MXene membranes for electrochemical energy storage applications.
- Inexpensive multi-walled CNTs control the structure of MXene membranes and improve their ion-transport properties.