Development of Poly(arylene ether sulfone) based MXene Composite Material With Enhanced Conductive Properties

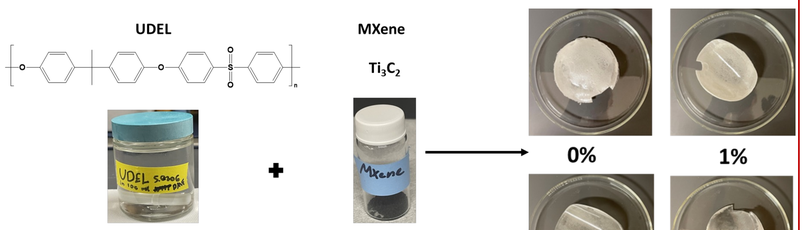
Anna Huszar, Sanjay Singh, Dr. Natalie Arnett (PI)
FAMU-FSU College of Engineering, Chemical and Biomedical Engineering Department
2077 E Paul Dirac Dr Tallahassee, FL 32310

Abstract

MXenes, 2D transition metal carbides, express high electric conductivity and thermal stability rates, as well as a 2D-layered structure. Bromine-terminated MXenes were etched from their corresponding MAX phase and exhibited characteristic XRD peak-layer separations at the 9th? Degree. UDEL -PSU is a thermally stable, mechanically robust transparent plastic with high heat resistance and hydrolytic stability. Solutions of UDEL were prepared by melting the commercially available pellets in DMF solution at a 5 weight/volume percent. The objective of the research is to effectively combine MXenes (Ti3C2Tx) with UDEL- Polysulfone thermoplastic to fabricate composite materials with improved thermal and conductive properties. MXenes were introduced into the UDEL matrix and asymmetrically cast into films with different weight/ volume percent concentrations. Mechanical and characterization testing on the resulting samples was performed to assess thermal capabilities, as well as MXene dispersion in the membrane. Additional conductivity testing was performed to assess the change in the electric conductivity of the binder polymer. It is expected that merging the individual properties of UDEL and MXenes will lead to characteristics that can be applied to conductive ink manufacturing.

Project Objective

To develop composite membranes of Bisphenol A based Poly(arylene sulfone) (UDEL) with MXenes to Enhanced Conductive Properties

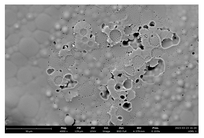


Film Formation

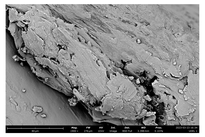
- 1%, 5% and 10% (w/v) of MXene dispersed in DMF was added to UDEL (20 wt%)
- Stirred for 24H and casted in Petri dish
- Membranes were dried for 24H using a heating lamp (80 °C).

Preliminary Research: *UDEL-MXeneYY Films*

Issue to address: UDEL films should be transparent and amorphous



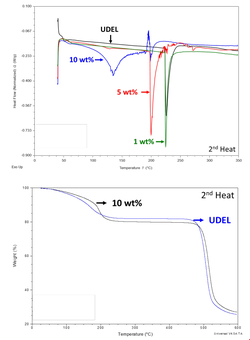
Top View



Side View

SEM: Illustrated heterogeneity and phase separation between MXenes from UDEL

DSC: Unexpected T_m peak was observed for amorphous UDEL films. Higher MXene concentration resulted in smaller T_m peaks.

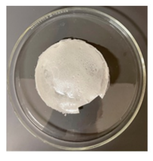


TGA: Small increase in thermal stability indicated low Mxene loading into UDEL.

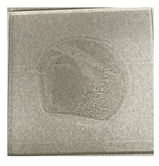
Current Research

Improve properties of UDEL-MXeneYY composite membranes using purified UDEL solutions

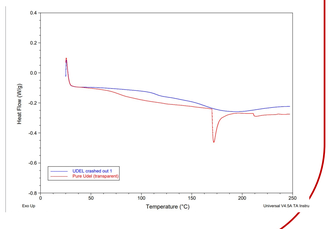
1. **Prepare UDEL solution (5 wt%) in DMF**
2. **Precipitated in DI water and drying in vacuum oven.**
3. **Redissolved purified UDEL in DMF and filtering prior to film formation.**
4. UDEL-MXeneYY composite films were cast as described before.



UDEL Film *Unpurified*



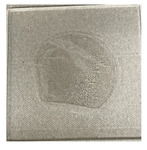
UDEL Film *Purified*



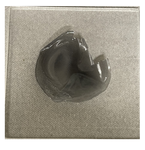
DSC: Demonstrated the loss of unexpected Tm peak when UDEL was purified.

Results and Discussion

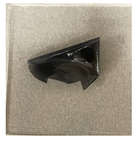
UDEL-MXeneYY composite films were cast as described before.



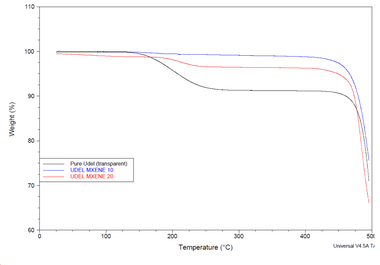
UDEL Film



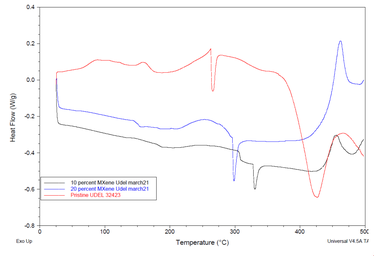
UDEL-Mxene10



UDEL-Mxene20



TGA Comparison



DSC Comparison

Conclusion and Future Work

Further Composite Characterization
-Scanning Electron Microscopy: Analysis of MXene dispersion in composite material
-Dynamic Mechanical Analysis: Assessment of further mechanical properties

Future Application
- Creation of Conductive Ink for 3D Printing

References

1)Junbin Liao and Zhibin Ye, Batteries 2018, 4, 22; doi:10.3390/batteries4020022
2)https://www.science.org/doi/10.1126/science.abf1581
3)Ilkay Ozaytekin, *Polymer Composites*, 2014
4)Junbin Liao and Zhibin Ye , Electrochimica Acta 259 (2018) 626e636

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