Kyle J. Matthews

1535 Village Greene Blvd., Bensalem, PA 19020
Cell: (267) 275-5543
kjm388@drexel.edu

Education

Drexel University *Philadelphia, PA*
PhD in Materials Science & Engineering **September 2020 – Present**
Cumulative GPA: 3.82
B.S. in Materials Science & Engineering Awarded: June 2020

Research Experience

PhD Candidate ***January 2022 – Present***
Drexel University- Nanomaterials Institute

The main focus of this work is to use MXenes as electrodes in zinc-based energy storage systems. Starting with titanium carbide ($Ti_3C_2T_x$), the charge storage mechanism in multiple aqueous zinc electorlytes is being studied using *in-situ* and classical electrochemical techniques. These include, but are not limited to cyclic voltammetry, electrochemical impedance spectroscopy, galvanostatic charge/discharge, *in-situ* X-Ray diffraction ans *in-situ* UV-Vis spectroscopy. These techniques will reveal the redox and intercalation activity occurring in $Ti_3C_2T_x$. Following this work, the choice of MXene and electrolyte will be tuned to achienve optimal cathode performance for different energy storage systems including zinc metal/ion batteries, zinc hybrid ion capacitors, and zinc ion capacitors.
Advisor: Dr. Yury Gogotsi

PhD Student ***September 2020 – January 2022***
Drexel University- Nanomaterials Institute

This work has focused on the improvement of V_2CT_x MXene stability and properties through improved synthesis and solution processing methods. Through new mixed-acid etchants that reduce inherent oxidation during synthesis, and an ion-exchange driven process to protect the MXene after synthesis, the shelf life of V_2CT_x was increased by over an order of magnitude while improving conductivity properties. This improvement in stability allowed for testing in different electrochemical systems and comparison to other MXenes. V_2CT_x and $V_4C_3T_x$ MXenes were tested in acidic and basic electrolytes, revealing unique electrochemical differences between previously studied Ti-based MXenes and V-based MXenes. Additionally, the distinct differences in V_2CT_x and $V_4C_3T_x$ MXenes themselves reveal how the number of layers in the 2D MXene structure can change the redox potentials and stable electrochemical windows.
Advisor: Dr. Yury Gogotsi

Senior Design *September 2019 – June 2020*
Drexel University- Sensor & Functional Materials Group *Philadelphia, PA*

The goal of our senior design group was to stabilize the photoluminescent properties of organometal halide perovskites through the encapsulation of crystals in a polymer matrix. Organometal halide perovskites have potential applications ranging from LEDs, light downconverters, solar concentrators, and materials for bioimaging. Different polymers were studied, and polyvinylidene difluoride (PVDF) was chosen for its flexibility and transparency in thin films, its hydrophobicity, and its piezoelectric phases. Successful composites of $MAPbBr_3$/$MAPbI_3$ and PVDF were created using drop casting, spin coating, and doctor blading methods of film formation. The stability of films with varying ratios of polymer to perovskite was studied in water, and the composites showed significant stability increases.
Advisor: Dr. Wei-Heng Shih

Independent Research *January 2020 – April 2020*

Drexel University- Sensor & Functional Materials Group *Philadelphia, PA*

Investigated Polydimethylsiloxane (PDMS) as a stabilizing encapsulant for methyl-ammonium lead bromide ($MAPbBr_3$) perovskite nanocrystals. The perovskites were synthesized using ligand-assisted reprecipitation (LARP). Composites were formed by mixing the perovskites and PDMS before curing. After curing, the composites were tested for stability in water and showed extended stability with virtually no decrease in photoluminescence

Advisor: Dr. Wei-Heng Shih

NREIP - Materials Researcher *June 2018 - September 2018*

Naval Surface Warfare Center Carderock *Bethesda, MD*

Used optical and electron microscopy techniques on various aluminum samples that were collected from active use or similar conditions recreated in the lab. The goal of these experiments was to gain insight into the precipitation of unwanted phases in different aluminum grades with varying microstructures. This information could be used to develop a trend that could be used to select materials and processes that mitigate sensitization. Additionally, G67 corrosion tests were carried out on the same materials to gain insight on the rate of corrosion associated with these alloys under different levels of sensitization.

Advisor: Dr. William Golumbfskie

Research Co-op *April 2018 – June 2018*

Drexel University - Dynamic Characterization Group *Philadelphia, PA*

Worked with a group of researchers from the materials science & engineering departments at Drexel & Carnegie Mellon University as well as the mechanical engineering department at Drexel University. This group plastically deformed copper samples, analyzed their microstructure using advanced characterization techniques, such as High-Resolution Electron Backscatter Diffraction (HR-EBSD), and applied computational dictionary indexing to compare to Hough-transformation based indexing. These datasets were run through a MATLAB program to quantify the dislocation content in the materials. The goal of these experiments was to apply computation and modeling to better understand the formation of dislocations in FCC materials.

Advisor: Dr. Mitra Taheri

STAR Scholar *June 2017 – September 2017*

Drexel University - Dynamic Characterization Group *Philadelphia, PA*

Studied the application of soft magnetic composites (SMCs) in additive manufacturing. I worked with GKN Hoeganaes to focus initially on binder-jet additive manufacturing with a coated ferrite powder known as AncorLam. Scanning Electron Microscopy (SEM) and Energy Dispersive X-Ray Spectroscopy (EDS) were performed on the AncorLam powder to confirm particle size and distribution of coating. Parts in various shapes for mechanical and magnetic tests were printed and sintered successfully. The goal of this project was to study the feasibility of using the complex geometries capable in additive manufacturing in conjunction with the low core losses present in SMCs for use in electric motor components.

Advisor: Dr. Mitra Taheri

Undergraduate Research *Sep 2016-Jun 2017/Sep 2017-Apr 2018*

Drexel University - Dynamic Characterization Group *Philadelphia, PA*

I joined the Dynamic Characterization Group and began to assist in lab work and attend group meetings. After being briefed on standard lab practices and safety measures, I was instructed in metallographic preparation using manual & automated equipment, which included sample

sectioning, polishing, and optical microscopy. I prepared a variety of materials using these skills, including steel, aluminum, and additive manufactured samples. This experience gave me the necessary lab skills to move seamlessly into larger projects when possible, and the knowledge to understand the questions and rationale of research projects.
Advisor: Dr. Mitra Taheri

Publications

- (In Preparation) **K. Matthews**, A. VahidMohammadi, D. Zhang, L. Liu, P. Simon, Y. Gogotsi. Electrochemical Properties of MXene Electrodes in Aqueous Zinc Electrolytes. **2022**
- (Submitted 7/12/22) T.B. Sobyra, **K. Matthews**, T. Mathis, Y. Gogotsi, P. Fenter. *Operando* X-ray Scattering Reveals the Dynamical Response of Ti_3C_2 MXene Thin Films During Electrochemical Cycling. *ACS Energy Letters*. **2022**
- (Submitted 7/11/22) M. Saraf, C.E. Shuck, N. Norouzi, **K. Matthews**, C. Inman, T. Zhang, E. Pomerantseva, Y. Gogotsi. Free-Standing α-MoO_3/Ti_3C_2 MXene Hybrid Electrode in Water-in-Salt Electrolytes. *Energy & Environmental Materials*. **2022**
- (Submitted 5/3/22) T. Zhang, **K. Matthews**, M. Han, A. Vahidmohammadi, Y. Gogotsi. Pseudocapacitance of Vanadium Carbide MXenes in Basic and Acidic Aqueous Electrolytes. *ACS Energy Letters*. **2022**
- (Submitted 4/29/22) C. Inman, V. Sedajova, **K. Matthews**, J. Gravlin, J. Busa, C.E. Shuck, A. Vahidmohammadi, M. Shekhirev, A. Bakandritsos, M. Otyepka, Y. Gogotsi. Shear delamination of multilayer MXenes. *Journal of Materials Research*. **2022**
- (Submitted 4/21/22) S. Nam, M. Mahato, **K. Matthews**, R.W. Lord, P. Thangasamy, C.W. Ahn, Y. Gogotsi, I. Oh. Bimetal Organic Framework-$Ti_3C_2T_x$ MXene with Metalloporphyrin Electrocatalyst for Lithium-Oxygen Batteries. *Advancd Energy Materials*. **2022**
- **K. Matthews**, T. Zhang, C. Shuck, A. VahidMohammadi, Y. Gogotsi. Guidelines for Synthesis and Processing of Chemically Stable Two-Dimensional V_2CT_x MXene. *Chemistry of Materials.* **2021**, published online - Cover article
- D. Foley, C. Pate, **K. Matthews,** X. Zhao, N. Savino, M. Degraef, L. Lamberson, M. Taheri. Application of Forward Modelling and Dictionary Indexing to EBSD Orientation Data as a Means of Quantifying Dislocation Substructure Formation in FCC Metals. *Microscopy and Microanalysis. **2019**, 25*(S2), 208-209.
- N. Benack, T. Wang, **K. Matthews,** M. Taheri. Additive Manufacturing Methods for Soft Magnetic Composites (SMCs). *Microscopy and Microanalysis. **2018**, 24*(S1), 1066-1067.

Presentations

- (Upcoming) **K. Matthews**, A. VahidMohammadi, D. Zhang, L. Liu, P. Simon, Y. Gogotsi. Electrochemical Properties of MXene Electrodes in Aqueous Zinc Electrolytes. ECS Fall 2022, Atlanta, GA, oral presentation
- (Upcoming) **K. Matthews**, T. Zhang, C. Shuck, A. VahidMohammadi, Y. Gogotsi. Guidelines for Synthesis and Processing of Chemically Stable Two-Dimensional V_2CT_x MXene. The 2nd International MXene Conference, Drexel University, Philadelphia, PA, poster presentation
- **K. Matthews**, T. Zhang, M. Han, A. VahidMohammadi, Y. Gogotsi. Pseudocapacitance of Vanadium Containing MXenes in Aqueous Electrolytes. ACS MARM 2022, Ewing, NJ, oral presentation

- **K. Matthews**, T. Zhang, C. Shuck, A. VahidMohammadi, Y. Gogotsi. Ion Exchange Coupled with Flocculation Extends Oxidation Stability of V_2CT_x MXene. MRS Spring meeting 2022, Honolulu, HI, poster presentation
- **K. Matthews**, T. Zhang, C. Shuck, A. VahidMohammadi, Y. Gogotsi. Synthesis and Processing of Chemically Stable V_2CT_x MXene with Improved Properties. MRS Fall meeting 2021, Boston, MA, oral presentation

Patents

- Y. Gogotsi, A. VahidMohammadi, **K. Matthews**, T. Zhang. Oxidation Inhibitors for Two-Dimensional Carbides and Nitrides. US Provisional Patent No. 63/231,333, filed 8/10/2021

Awards

- Koerner Fellowship *Awarded: March 2022*
- MRS Spring 2022 "24-7" Video Contest Winner *Awarded: May 2022*

Teaching Experience

Graduate Teaching Assistant – Drexel University *Philadelphia, PA*
MATE 280: Advanced Materials Laboratory *Fall 2020*

Specialized Skills

Technical: Electrochemical measurement techniques, Optical and Scanning Electron Microscopy, Electron Backscatter Diffraction, Energy Dispersive X-Ray Spectroscopy, X-Ray Diffraction, UV-Vis Spectrometry, Zeta-Potential measurements, Dynamic Light Scattering
Laboratory: MXene synthesis, nanomaterial (MXene/carbon nanotube) solution processing, Perovskite synthesis (Ligand-Assisted Reprecipitation, Bulk synthesis), aerogel fabrication, electrochemical cell assembly and electrode fabrication, mechanical & electrolytic Polishing, chemical etching, sample sectioning, micro-indentation
Software: Bio-Logic EC Lab, Origin, ImageJ, MATLAB, Visual Basic (Excel/Word), TSL OIM Analysis, Abaqus, Adobe Photoshop/Illustrator, Microsoft Office