

Mark Anayee

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EDUCATION

Drexel University

Ph.D. in Materials Science and Engineering, NSF Fellow

- A. J. Drexel Nanomaterials Institute – Advisor: Yury Gogotsi
- Thesis: Mechanism and Kinetics of MXene Synthesis

Philadelphia, PA, USA
Jun. 2018 – Expected Jun. 2023

Clemson University

Bachelor of Science in Materials Science and Engineering & Chemistry minor

Clemson, SC, USA
Aug. 2014 – Dec. 2017

RESEARCH EXPERIENCE

Drexel University: A. J. Drexel Nanomaterials Institute, MSE Department

Advisor: Yury Gogotsi

Jun. 2018 – Present
Philadelphia, PA, USA

- Investigated the mechanism and kinetics of MXene synthesis - Promising materials for energy storage, wearable electronics, and medical devices comprising a family of two-dimensional transition metal carbide and nitrides
- Developed cells for in-situ microscopy, profilometry, and spectroscopy to study etching reactions
- Explored chemical vapor transport etching reactions as alternatives for large-scale rapid synthesis of MXenes
- Expertise in X-ray Photoelectron Spectroscopy a variety of sample forms and projects (9 publications including XPS data)
- Maintained equipment and trained others in thermal analysis and mass spectrometry, optical profilometry, and air-free material synthesis

Korea Advanced Institute of Science and Technology: National Nanofabrication Center

Advisor: Chi Won Ahn

Aug. 2021 – Nov. 2021
Daejeon, South Korea

- Supported efforts to improve MAX and MXene synthesis, electron microscopy studies of MXene etching mechanism, and zero-valent metal intercalation into MXenes

King Abdullah University of Science and Technology, MSE Department

Advisor: Husam N. Alshareef

Sep. 2019 – Dec. 2019
Thuwal, Saudi Arabia

- Strengthened collaboration between Drexel University and KAUST through knowledge-transfer of optimal MXene synthesis and processing procedures
- Initiated a new research direction by applying Electron Paramagnetic Resonance spectroscopy to MXenes

Clemson University, MSE Department

Advisor: Igor Luzinov

May 2016 – Dec. 2017
Clemson, SC, USA

- Functionalization of graphene oxide (GO) with multi-functional polymers to aid in exfoliation of sheets and adhesion strength to both hydrophilic and hydrophobic substrates.
- Investigated the surface chemistry of GO composite films following thermal annealing and chemical reduction
- Developed light, pressure, and humidity sensors, and triboelectric nanogenerators using the GO-polymer composites

PUBLICATIONS

1. **M. Anayee**, C. E. Shuck, M. Shekhirev, A. Z. Goad, R. Wang, Y. Gogotsi, Kinetics of Ti_3AlC_2 etching for Ti_3C_2Tx MXene synthesis, *Chemistry of Materials*, **2022**, under review
2. P. P. Michalowski, **M. Anayee**, T. S. Mathis, S. Kozdra, A. Wojcik, K. Hantansirisakul, I. Jozwik, A. Piatkowska, M. Mozdzonek, A. Malinowska, R. Diduszko, E. Wierzbicka, Y. Gogotsi, Oxycarbide MXenes and MAX phases identified using monoatomic layer-by-layer analysis with ultralow-energy secondary ion mass spectrometry, *Nature Nanotechnology*, **2022**, Accepted

3. H. Zhou, S. J. Han, H.-D. Lee, D. Zhang, **M. Anayee**, S.-H. Jo, Y. Gogotsi, T.-W. Lee, Overcoming the Limitations of MXene Electrodes for Solution-Processed Optoelectronic Devices, *Advanced Materials*, **2022**, Accepted
4. Y.-J. Kim, S. J. Kim, D. Seo, Y. Chae, **M. Anayee**, Y. Lee, Y. Gogotsi, C. W. Ahn, H.-T. Jung, Etching mechanism of monoatomic aluminum layers during MXene synthesis, *Chemistry of Materials*, **2021**, 33, 16, 6346
5. T. S. Mathis, K. Maleski, A. Goad, A. Sarycheva, **M. Anayee**, A. C. Foucher, K. Hantanasirisakul, C. E. Shuck, E. A. Stach, Y. Gogotsi, Modified MAX Phase Synthesis for Environmentally Stable and Highly Conductive Ti₃C₂ MXene, *ACS Nano*, **2021**, 15, 6420
6. J. Tang, T. S. Mathis, X. Zhong, X. Xiao, H. Wang, **M. Anayee**, F. Pan, B. Xu, Y. Gogotsi, Optimizing Ion Pathway in Titanium Carbide MXene for Practical High-Rate Supercapacitor, *Advanced Energy Materials*, **2021**, 11, 4, 2003025
7. X. Xiao, W. Yao, J. Tang, C. Liu, R. Lian, P. Urbankowski, **M. Anayee**, S. He, J. Li, H. Wang, Y. Gao, Y. Wei, Y. Gogotsi, Interconnected Two-dimensional Arrays of Niobium Nitride Nanocrystals as Stable Lithium Host, *Batteries & Supercaps*, **2020**, 4, 1, 106
8. K. J. Griffith, M. A. Hope, P. J. Reeves, **M. Anayee**, Y. Gogotsi, C. P. Grey, Bulk and Surface Chemistry of the Niobium MAX and MXene Phases from Multinuclear Solid-State NMR Spectroscopy, *Journal of American Chemical Society*, **2020**, 142, 44, 18924
9. **M. Anayee**, N. Kurra, M. Alhabeab, M. Seredych, M. N. Hedhili, A. H. Emwas, H. N. Alshareef, B. Anasori, Y. Gogotsi, Role of acid mixtures etching on the surface chemistry and sodium ion storage in Ti₃C₂Tx MXene, *Chemical Communications*, **2020**, 56, 45, 6090
10. A. Levitt, D. Hegh, P. Phillips, S. Uzun, **M. Anayee**, J. M. Razal, Y. Gogotsi, G. Dion, 3D knitted energy storage textiles using MXene-coated yarns, *Materials Today*, **2020**, 34, 17
11. C. E. Shuck, A. Sarycheva, **M. Anayee**, A. S. Levitt, Y. Zhu, S. Uzun, V. Balitskiy, V. Zahorodna, O. Gogotsi, Y. Gogotsi, Scalable Synthesis of Ti₃C₂Tx MXene, *Advanced Engineering Materials*, **2020**, 22, 3, 1901241
12. H. Riazi, **M. Anayee**, K. Hantanasirisakul, A. A. Shamsabadi, B. Anasori, Y. Gogotsi, M. Soroush, Surface Modification of a MXene by an Aminosilane Coupling Agent, *Advanced Materials Interfaces*, **2020**, 7, 6, 1902008
13. S. Uzun, S. Seyedin, A. L. Stoltzfus, A. S. Levitt, M. Alhabeab, **M. Anayee**, C. J. Strobel, J. M. Razal, G. Dion, Y. Gogotsi, Knittable and Washable Multifunctional MXene-Coated Cellulose Yarns, *Advanced Materials*, **2019**, 29, 45, 1905015
14. M. Savchak, N. Borodinov, R. Burtovyy, **M. Anayee**, K. Hu, R. Ma, A. Grant, H. Li, D. B. Cutshall, Y. Wen, G. Koley, W. R. Harrell, G. Chumanov, V. Tsukruk, I. Luzinov, Highly conductive and transparent reduced graphene oxide nanoscale films via thermal conversion of polymer-encapsulated graphene oxide sheets, *ACS Applied Materials and Interfaces*, **2019**, 10, 4, 3975
15. H. M. Gordhan, S. L. Patrick, M. I. Swasy, A. M. Hackler, **M. Anayee**, J. E. Golden, J. C. Morris, D. C. Whitehead, Evaluation of substituted ebselen derivatives as potential trypanocidal agents, *Bioorganic & Medicinal Chemistry Letters*, **2017**, 27, 3, 537

PRESENTATIONS

- Invited speaker and panel discussion - International MXene conference Philadelphia, PA, USA — Aug. 2022
- Seminars - Yonsei University and Seoul National University Seoul, South Korea — Nov. 2021
- Oral talks - RPGR and IU-MRS conferences Seoul and Jeju, South Korea — Oct. 2021
- Oral talk - American Chemical Society (ACS) spring virtual meeting Virtual — Apr. 2021
- Poster - Drexel Emerging Graduate Scholars conference Philadelphia, PA — Apr. 2019
- Poster - Materials Science & Technology. conference Pittsburgh, PA — Oct. 2017

AWARDS

- DOE Graduate Assistance in Areas of National Need, Drexel University 2021
- Joseph & Shirley Carleone Fellowship, Drexel University 2021
- George Hill Jr. Endowed Fellowship, Drexel University 2018, 2019, 2020
- Gold Graduate College Fellowship, Drexel University 2018
- Graduate Research Fellowship Program, National Science Foundation 2018
- SMART Fellowship Semi-Finalist, Department of Defense 2018
- Benjamin A. Gilman scholarship (declined), Institute of International Education 2017
- Palmetto Fellows scholarship and STEM enhancement, State of South Carolina 2014

INDUSTRY EXPERIENCE

- Ulbrich Specialty Wire Products** Jan. 2018 – Jun. 2018
New Product Development Intern Westminster, SC, USA
- Managed the development of a new process line in collaboration with Microbonds inc. for continuous coating of metal wires with nanoparticle solutions
 - Improved procedures and training guidelines for metallographic sample preparation, etching, and microscopy

TEACHING EXPERIENCE

- Drexel University** 2020–2022
MXene course instructor, twice per year
- Instructor for XPS analysis and Thermal Analysis of MXenes for MXene synthesis, processing, and characterization course (>100 virtual attendees worldwide)
- Clemson University: Academic Success Center** Jan. 2016 – Jan. 2017
Supplemental Instruction leader for Intro. to Statics and Intro. to Organic Chemistry
- Facilitated semiweekly collaborative group sessions for up to 30 students
 - Developed comprehensive session plans and worksheets to support understanding of specific course material and broad student engagement with active-learning concepts

SERVICE EXPERIENCE

- Materials Research Society, Drexel chapter** Jun. 2018 – Sep. 2019
- Organized various outreaching events ranging from fun science demonstrations to more technical lab facilities tours geared towards the general public, high school students and/or incoming 1st year college students
- Material Advantage, Clemson chapter** Jan. 2016 – Dec. 2017
- Led a team of 5 students in organizing, designing, building, and presenting a geodesic dome for the Domesday competition at the 2016 and 2017 MS&T conferences

MENTORING EXPERIENCE

1. Ervin Rems – MS student working on theoretical calculations of MXene synthesis Mar. 2022 – Sep. 2022
2. Jaehoon Choi – MS student working on spectroscopic analysis of solid-electrolyte interface Feb. 2022 – Sep. 2022
3. Eiara Fajardo – BS Co-Op student working on vapor synthesis of MXenes Mar. 2021 – Dec. 2021
4. Dimitrios Dogias – BS Co-Op student working on kinetics of MXene synthesis reaction Sep. 2020 – Mar. 2021
5. Raymond Zhang – BS/MS student working on MXene–Oxide heterostructures Jun. 2020 – Mar. 2021
– Work presented at Fall 2021 MS&T conference and thesis defended in May 2022
6. Senior design team of 4 students working on automated spray-coating system Sep. 2019 – Apr. 2020
– Work presented at Drexel Celebration of Engineering Design in Feb. 2020

SKILLS

Lab techniques: Expertise with X-ray Photoelectron Spectroscopy (XPS). Experience with Spectroscopy (Infrared, Raman, and UV-VIS), Thermal Analysis (TGA, DSC, MS), X-ray Diffraction (XRD), Profilometry (Laser and AFM), and Structural and Chemical Analysis (SEM and EDX)

Programming languages: Expertise with MATLAB. Experience with HTML/CSS/Javascript, Python, Mathematica, and L^AT_EX

Software: Expertise with CasaXPS and CrystalMaker. Experience with OriginLab, Avogadro, ChemDraw, Vesta, Solidworks, and MathCAD Prime

Languages: English - Fluent, Assyrian - Fluent, Arabic - Intermediate