LSU College of Engineering

Chemical Engineering

LECTURE SERIES

Dr. Michael Naguib

Associate Professor
Tulane University
Tuesday, October 1
10:30-11:30 pm
1124 Patrick Taylor Hall

Synthesis and Atomic/Nanoscale Engineering of 2D Materials for Electrochemical Energy Storage and Conversion

MXenes constitute a large family (50+ phases) of two-dimensional transition metal carbides/nitrides with a composition of Mn +1XnTx (M is an early transition metal, X is carbon or nitrogen, n =1-4, and Tx stands for surface terminations). Their exceptional electrical conductivity, redox activity and ion-hosting capabilities make them promising candidates for electrode materials in electrochemical energy storage and conversion. MXenes also offer an excellent platform for atomic and nanoscale engineering to target specific applications. In this context, we will explore examples where pre-intercalation has significantly altered MXene electrochemical behavior. One example is using pre-intercalation of alkylammonium (AA) cations with different chain lengths to study the effect of interlayer spacing in MXene on their performance as electrodes for supercapacitor in room-temperature ionic liquids (RTIL). These RTIL electrolytes that offer larger potential windows, leading to higher energy densities. We found that pre-intercalated MXene with an interlayer spacing of ≈ 2.2 nm can operate within a voltage window of > 3V in neat EMIMTFSI electrolyte and deliver a large specific capacitance of 257 F/g and high-energy density of 370 Wh/kg -an order of magnitude higher than pristine MXene- without compromising their high-power density. Additionally, we will discuss other atomic-scale manipulation strategies for MXenes, including applications in both electrochemical energy storage and the hydrogen evolution reaction. Lastly, we will highlight the recent discovery of 2D transition metal carbo-chalcogenides (TMCCs), extending the scope beyond MXenes and opening new avenues for research.

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Bio:

Michael Naguib is a Ken and Ruth Arnold Early Career Professor in Science and Engineering and an associate professor in the department of Physics and Engineering Physics at Tulane University, New Orleans, Louisiana, USA. Prior to joining Tulane in 2018, he was a Wigner Fellow (2014-2017) and Research Staff (2017-2018) at Oak Ridge National Laboratory. He received his PhD in Materials Science and Engineering at Drexel University in 2014 where he co-invented 2D MXenes in 2011. He has published 118 papers (with more than 51,000 citations and h-index of 66) in international journals and presented many plenary, keynote and invited lectures and seminars at a number of international conferences and universities. He has been listed as a Highly Cited Researcher by Clarivate Analytics five times and has received many awards such as NSF CAREER Award, Robert L. Coble Award, Kroto Award, Ross Coffin Purdy Award, Rising Star Award by Tulane University, MRS Gold Graduate Student Award, Graduate Excellence in Materials Science Award, Young Alumni Emerging Leader Award by Drexel University, and was listed as Drexel University Forty-Under-Forty. He is an Associate Editor of Energy Advances. His research group works on the synthesis and characterization of layered materials and novel nanomaterials with a focus on 2D materials for electrochemical energy storage and conversion and environmental applications.