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Abstract: The future renewable and sustainable energy society depends on our ability to efficiently and sustainably convert energy from one form to another and store it for later use. Cost effective, high performance energy storage and conversion systems are needed in all areas of our daily life from mobile electronics and transportation to industrial production and the smart grid. Currently available energy storage devices like batteries lack sufficient peak power capabilities and long cycle life. In this presentation, I will share our efforts on both converting solar energy into chemical fuels for long-term storage and storing chemical energy in supercapacitor devices that can be charged/discharged within seconds. Supercapacitors based on nanostructured interstitial nitrides have excellent power capabilities and unlimited cycles and the potential to revolutionize the energy storage space by delivering high energy density. Commercial supercapacitors based on carbons suffer from low energy density. I use advanced synthesis and various physical, structural, and electrochemical characterization tools in combination with in situ structural characterization techniques (i.e. X-ray absorption spectroscopy, neutron scattering, prompt-gamma activation analysis) to understand the charge storage mechanisms of interstitial nitrides (i.e. VN, Mo2N) as a strategy to increase their energy density and fully exploit their properties for supercapacitors. Owing to their excellent electronic properties, high-surface area, and facile tunability, two-dimensional (2D) nitride MXenes are suitable candidates for generating zero-carbon-emission hydrogen fuels via electrochemical water splitting. My research effort has led to the discovery of novel 2D nitride MXene catalysts (i.e. Ti2NTx, Ti4N3Tx) that can be highly active and efficient for the production of hydrogen fuel from water electrolysis. Ultimately, my research will allow our society to do things that otherwise would have not being possible such as charging our phones within seconds or fueling our vehicles with zero-carbon emission fuels.

About: Abdoulaye Djire, Ph.D., is a Georgia Institute of Technology Focus Fellow, University of Michigan Tech Transfer Technology Fellow, and a Postdoctoral Scholar working with Dr. Nathan Neale in the Chemistry and Nanoscience Center at the National Renewable Energy Laboratory (NREL) and Founder & President of the Djire Foundation Inc. He earned his associate degree in Economics from Ecole Nationale d’Administration de Bamako, his B.S. and Ph.D. in Chemical Engineering from Prairie View A&M University and the University of Michigan, respectively, under the guidance of Prof. Levi Thompson. His graduate research entailed understanding the charge storage mechanisms of high surface-area carbides and nitrides for energy storage applications. Prior to joining NREL, Dr. Djire led a team of engineers at a startup company in Michigan to develop new technologies for next-generation supercapacitors. Dr. Djire’s current research at NREL focusses on the structure-function relationships of the electrocatalytic and photocatalytic behavior of 2D carbides and nitrides MXenes for applications in energy storage and conversion.