Materials Science and Engineering Department

Fall Seminar Series

Discovery of Unusual Chemical Properties of MXenes and How It Challenges Our Understanding of Reactivity of Other Materials

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A large family of two-dimensional transition metal carbides and nitrides (MXenes) raises interest for many applications due to their high electrical conductivity, mechanical properties, potentially tunable electronic structure, nonlinear optical properties, and the ability to be manufactured in the thin film state. However, their chemistry that is key to development of almost all these applications, still remains poorly understood. Our initial attempts to understand MXene reactivity with oxygen and water brought about surprising results and raised profound questions related to reactivity of 2D materials as compared to their bulk analogues. In particular, our well-established classification of carbides is being challenged by these findings.

In this presentation we will also discuss our more recent progress in understanding fundamental MXene chemistry and illustrate how this understanding helps to suppress unwanted reactions and prolong stability of these materials. For example, suppressing oxidation and hydrolysis at high pH was demonstrated as an effective way to prolong shelf-life and stability of MXene aqueous colloids. Use of polyphosphate also has been shown to improve chemical stability of MXene aqueous colloids. Other selected examples illustrating connections between understanding MXene chemistry and development of their applications will also be considered.

Dr. Vadym Mochalin has received Ph.D. in Physical Chemistry from L. M. Litvinenko Institute of Physical Organic and Coal Chemistry, National Academy of Sciences of Ukraine and M.S. in Biochemistry (cum laude) from Donetsk National University, Ukraine. After spending some years at Drexel with Prof. Gogotsi, he is now Associate Professor of Chemistry at Missouri University of Science & Technology with joint appointment in the Department of Materials Science & Engineering. His current research interests include fundamental chemistry, synthesis, characterization, purification, chemical modification, modeling, and developing applications of nanodiamond, MXene, nanoonions, nanocarbons, and other nanomaterials for composites, energy storage, biomedical applications, and extreme environments. Dr. Mochalin has co-authored over a 100 research papers in peer reviewed journals, has been invited to write several book chapters and many review articles and is an inventor on 7 international patents. For many years he serves on the Editorial Board of Scientific Reports – a Nature Research journal. Since 2021 Dr. Mochalin also serves as editor of Diamond and Related Materials (Elsevier).

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