Electronic Materials and Photonics
Room 205 ABCD W - Session EM-ThM

Advances in Material Deposition Techniques

Moderators: Francois Fabreguette, Micron, **John Muth**, North Carolina State University

8:45am **EM-ThM-4 Unveiling the Synergy of Er_2O_3 and Mxene for Efficient and Durable Energy Storage Systems***, M.R. Ambika,* Ramaiah institute of Technology, India

MXenes, a rapidly expanding family of two-dimensional transition metal carbides and/or nitrides, have sparked intense scientific interest due to their unique combination of metallic conductivity, tunable surface chemistry, and hydrophilic behavior (surface area=15.247 m^2 g^{-1}). These properties not only make them ideal candidates for standalone electrode materials but also allow seamless integration with other functional compounds to form high-performance composites. In this study, a hybrid material was designed by coupling Ti_3C_2 MXene with Erbium oxide (Er_2O_3), a rare-earth metal oxide known for its redox-active behavior, to engineer a next-generation electrode for energy storage devices. The layered Ti_3C_2 sheets were synthesized via selective chemical etching, followed by hydrothermal composite formation with Er_2O_3. The structural, morphological, and chemical characteristics of the resulting materials were thoroughly analyzed using XRD, FESEM, FTIR, and Raman spectroscopy. The hybrid system demonstrated a striking enhancement in electrochemical performance due to the synergistic interplay between the high conductivity of MXene and the faradaic contribution from Er_2O_3. The pure MXene electrode delivered a specific capacitance of 476.19 F g^{-1}, while the optimized MXene/Er_2O_3 composite achieved a high capacitance. In addition, there was an improvement in cycling stability (85.99%) of the composite when compared to MXene (77.4%) for 2000 cycles. This remarkable improvement underscores the potential of rare-earth metal oxide/MXene hybrids in advancing the design of efficient, high-capacity energy storage systems. The work opens new avenues for tailoring MXene-based architectures toward scalable, high-performance energy storage and conversion technologies.

9:00am **EM-ThM-5 The CO_x Thermal Oxidation Process for CO_2 Capture***, Marshall Buffett,* Voiland School on Chemical Engineering

Rising carbon dioxide emissions have driven research into sustainable methods for converting carbon rich waste gases from industry into value-added materials. One such method is the CO_x Thermal Oxidation Process (CO-OP), in which CO or CO_2 reacts with magnesium silicide (Mg_2Si) to produce crystalline silicon encapsulated in both graphitic and amorphous carbon. The resulting composite shows potential as a lithium-ion battery anode, while the process itself offers a method for CO_2 removal. However, industrial gas streams are rarely pure and the influence of feed composition on CO-OP remains unexplored. While CO-OP with CO_2 has been studied, implementation in industrial processes would be impractical if it required purified CO_2. This study investigates how feed compositions common in methane steam reforming (CO_2, CO, CO+H_2, and CO_2+H_2) affect the morphology of the produced composite and how these morphology changes influence battery performance. Preliminary results indicate that CO increases the carbon content of the composite as compared to CO_2 and creates a core/shell structure, increasing mechanical stability. Morphology, surface area, and carbon distribution vary significantly with gas composition which in turn affects the battery performance significantly. X-ray diffraction confirms high purity across all samples after leaching. These insights guide future improvement of CO-OP for integration with industrial emission streams, creating a new method of carbon capture and improving battery technology.

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