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Unlocking New Possibilities in Energy Storage and Conversion with MNenes

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The widespread adoption of renewable energy demands reliable energy storage solutions, which are currently held back by issues related to performance, cost, and/or ease of use. To tackle these issues, researchers have explored two-dimensional (2D) materials as cost-effective, high-performance electrocatalysts and electrode materials. Among these 2D materials, MXenes, a distinct category of carbides and nitrides, have gained prominence owing to their exceptional tunability, conductivity, and high surface area-to-volume ratio. Nitride MXenes (MNenes), in particular, excel in these properties compared to their carbide counterparts, but their synthesis method remains unclear. In this presentation, I will introduce the oxygen-assisted molten salt fluoride etching synthesis method developed in our laboratory, enabling the production of phase-pure MNene materials. Furthermore, I will delve into the enhanced performance of these MNenes for the nitrogen reduction reaction (NRR), carbon dioxide reduction reaction (CO_2RR), hydrogen evolution reaction (HER), and applications pertaining to energy storage. Additionally, I will provide real-time mechanistic insights into the underlying mechanisms of each system. I will wrap up by discussing some future directions and opportunities for MNenes in catalysis and energy storage, emphasizing their potential impact on advancing these fields.