

ABSTRACT:

Advanced MXene–Tin Hybrid Nanostructures for Lithium-Ion Battery Applications

M. Tunesi^a, B. P. Sharma^b, R. A. Soomro^{c, a}, E. Placidi^a

^aDepartment of Physics, Sapienza University of Rome, Piazzale Aldo Moro 2, 00185 Rome, Italy

^bBeijing Key Laboratory of Electrochemical Process and Technology of Materials,
Beijing University of Chemical Technology, Beijing 100029, PR China

^cInstitute of Advanced Energy Storage Materials and Technologies, School of Chemistry and Chemical
Engineering, Yan'an University, Yan'an 716000, China

The growing integration of renewable energy sources requires the development of efficient and reliable energy storage systems. Among the available technologies, lithium-ion batteries (LIBs) stand out due to their high energy density and long operational lifespan. Nevertheless, the widespread use of conventional graphite anodes is limited by their relatively low theoretical capacity, which constrains further improvements in energy storage performance. In this context, tin-based materials have emerged as promising alternatives owing to their high theoretical capacity; however, their practical application is hindered by intrinsic drawbacks such as low electrical conductivity and significant volume expansion during cycling.

In this work, the incorporation of MXene materials is explored as a strategy to overcome these limitations and enhance the electrochemical performance of tin-based anodes. A range of MXene-integrated nanocomposites was developed, including MOF-derived SnO₂/MXene, SnSe/MXene, Sn/SnO₂@C/TiO₂, and SnTe@C/TiO₂ systems. Through rational structural design and interface engineering, these materials were tailored to improve charge transport, mitigate volume changes, and enhance overall electrode stability.

Electrochemical characterization reveals that the resulting nanocomposites exhibit high reversible capacities, remarkable cycling stability, and excellent rate performance. These findings demonstrate the effectiveness of MXene integration in optimizing lithium storage properties in tin-based systems.

This presentation will discuss the synthesis strategies, structural features, and electrochemical behavior of these MXene-based nanocomposite anodes, emphasizing their potential for advancing next-generation lithium-ion battery technologies.