# Chemical and Electrochemical Modulation of Physical Properties of MXenes

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MXenes (carbides, nitrides, oxycarbides and carbonitrides of early transition metals) are a very large family of 2D materials. They have a chemical formula of $M_{n+1}X_nT_x$, where M represents a transition metal (Ti, Mo, Nb, V, Cr, etc.), X is either carbon and/or nitrogen (n=1, 2, 3 or 4), and $T_x$ represents surface terminations. The large variety of structures and compositions, availability of solid solutions on M and X sites, and control of surface terminations, such as O, OH, halogens, chalcogens, etc., offer a plethora of chemistries to investigate.[1] Combining their plasmonic properties with ease in aqueous processing, high electronic conductivity (over 20,000 S/cm) and excellent mechanical properties, which exceed other solution-processable 2D materials, MXenes have the characteristics necessary to develop as optical and electronic materials.[2] Inherent to their 2D structure, the charge carriers responsible for MXene's optical responses and electronic transport are very close to an external interface that has exceptional ability to undergo reversible chemical and electrochemical reactions to add or change surface terminations. By design of the MXene composition, the carrier plasma can be rendered sensitive to the resulting changes in band structure and state-filling. As a result, properties of MXenes, such as conductivity, work function, plasmon resonance; visible, IR and microwave absorption/reflection can be controlled by introducing reversible or irreversible changes in their surface chemistry. Taking into account that electrochemical charge/discharge with milliseconds frequency is possible for MXenes, electrochemical modulation of optical and electronic properties can facilitate new ways of influencing material interactions with electromagnetic waves over visible, IR, THz and even GHz wavelength ranges. Many technological advances can be enabled by these chemically responsive, conductive materials in the fields of electromagnetic interference shielding, antennas, sensors, and other devices. In this talk, I explain how optical, electronic and transport properties of MXenes can be manipulated by tuning their chemical composition. This presentation will also demonstrate electrochemical modulation of the optoelectronic properties and describe potential applications of MXenes in photonic, optoelectronic and electrochemical devices.[1,3,4]

References

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