MXenes Across the Electromagnetic Spectrum – from UV to Microwaves

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MXenes are a very large family of 2D materials with diverse properties. They have a general 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.[1] More than 50 MXene compositions have already been reported, and more than 100 stoichiometric structures have been predicted. Availability of solid solutions on the M site (including high-entropy MXenes) and X site (including carbonitrides and oxycarbides) and control of surface terminations, such as O, OH, F, Cl, S, Se, Te, etc., create an opportunity for the atomistic design of numerous new structures and chemistries. Combining the plasmonic properties with ease in processing, high electronic conductivity (over 20,000 S/cm) and excellent mechanical properties, MXenes can be used as optical and electronic materials. They offer chemically controlled optical and electronic properties that facilitate new ways of influencing material interactions with electromagnetic waves over UV-vis, IR, THz, and GHz ranges.[2-4] Inherent to their 2D structure, the charge carriers responsible for MXene's optical responses and electronic transport are very close to the surface that can undergo reversible chemical and electrochemical reactions to add or change surface terminations.[2] By design of the MXene composition, the carrier plasma can be rendered either sensitive to or uncommonly robust against the changes in the band structure and state-filling. MXenes have already shown great promise in applications such as electromagnetic interference shielding, photothermal therapy, electron transport layers of OLEDs and solar cells, photodetectors, and thermal radiation management. This presentation will explain how optical, electronic and transport properties of MXenes can be controlled by tuning their chemical composition. I'll also demonstrate electrochemical modulation of MXenes' optoelectronic properties[4] and describe potential photonic and optoelectronic applications of MXenes.[2-4]

References

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