Electromagnetic Shielding of 2D Transition Metal Carbides and Carbonitrides (MXenes)

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Two-dimensional (2D) MXenes are a newly discovered family of transition metal carbides, nitrides, and carbonitrides. Their outstanding electrical conductivities of $>10^4$ S cm^{-1} in 2D morphology, low density, mechanical flexibility, easy processability, and structural controllability extends their application scope to compete with existing conventional 2D materials. $Ti_3C_2T_x$, the representative candidate of the MXene family, exhibits an EMI shielding effectiveness of 92 dB at 45 micrometer thickness, whereas a 55 nanometer thick film can provide 99% shielding against EMI, which is outstanding for highly-compacted electronics. A transition metal carbonitride, Ti_3CNT_x MXene, with a moderate electrical conductivity provides a higher shielding effectiveness compared to more conductive $Ti_3C_2T_x$ or metal foils of the same thickness. This exceptional shielding performance of Ti_3CNT_x was achieved by thermal annealing and is attributed to an anomalously high absorption of electromagnetic waves in the layered metamaterial-like porous structure. With high absorption of EM waves at minimal thickness, MXenes are ideal for real applications in smart 5G electronics.