

Flexible MXene-based Jerusalem-Cross Metasurfaces for Absorption-dominated Broadband and High-Efficiency Green Electromagnetic Interference Shielding

Garima Choudhary¹, Sanjoy Sur Roy¹, Debabrata Sahu¹, and P.K. Giri^{1,2}

¹Department of Physics, Indian Institute of Technology Guwahati, Guwahati 781039, India

²Centre for Nanotechnology, Indian Institute of Technology Guwahati, Guwahati 781039, India

c.garima@iitg.ac.in

The rapid evolution of information technologies demands adaptive, green electromagnetic interference (EMI) shielding materials capable of real-time response, high efficiency, and minimal secondary reflection. In this work, MXene-based Jerusalem-cross (MXJC) meta-atoms are introduced as key functional units that manipulate the phase, polarization, and impedance matching of reflected electromagnetic waves, thereby effectively suppressing secondary radiation from reflections and enabling efficient green EMI shielding. Benefiting from the high electrical conductivity and strong dipole polarization of $\text{Ti}_3\text{C}_2\text{T}_x$ MXene nanosheets, the resulting meta-film exhibits excellent EMI shielding performance. It achieves a maximum shielding effectiveness (SE) of 61.45 dB and a green index >1 over 252 MHz, highlighting its broadband shielding capability. More importantly, by extending classical electromagnetic equivalent circuit theory to micro-structured MXJC meta-films, a clear correlation between the microscopic meta-structure design and macroscopic shielding behavior is established. Full-wave CST simulations are further employed to validate the equivalent circuit models and it reveals the underlying electromagnetic mechanisms. In addition, the flexible MXJC meta-film maintains robust EMI shielding performance under mechanical deformation, demonstrating outstanding flexibility and mechanical robustness. This work provides a promising pathway toward flexible, high-efficiency, and broadband MXJC meta-surfaces for advanced EMI shielding and absorption applications.

References

[1]. Wang, Xi-Xi, Hao-Tian Wu, Wen-Song Wang, Yu Luo, and Yuan-Jin Zheng. "Ti₃C₂ MXenes meta-film switching ultra-broadband and high-efficiency green EMI shielding." *Carbon* 213 (2023): 118267.