

MXene Nanoribbon Aerogel-Based Gradient Conductivity Electromagnetic Interference Shields with Unprecedented Combination of High Green Index and Shielding Effectiveness

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The need to minimize secondary electromagnetic pollution from shielded electronic devices has driven the development of electromagnetic interference (EMI) shields with a high green index (GI), defined as the ratio of absorption to reflection. However, achieving a high GI alongside a shielding effectiveness (SE) exceeding 50 dB remains a significant and unresolved challenge. A critical strategy for suppressing reflection and enhancing absorption is to reduce the impedance mismatch between the shield and free space, allowing incident radiation to penetrate deeper into the material. In this work, a sandwich-type architecture with a conductivity gradient is proposed, delivering both a high GI of approximately 2 and an exceptional SE of about 70 dB. The top layer incorporates a low-conductivity MXene nanoribbon aerogel embedded in a PEDOT:PSS matrix, which enhances absorption-dominated shielding behaviour. Additionally, the aerogel structure lowers the effective permittivity of the shield, further mitigating impedance mismatch in this nonmagnetic system. In contrast, the bottom layer consists of a MXene nanosheet-polymer with its high electrical conductivity to provide high SE. The EMI shielding mechanism is further validated through theoretical calculations of reflectance, electromagnetic simulations and density functional theory simulations. This design strategy demonstrates the potential of conductivity-gradient architectures as a promising route for developing next-generation green EMI shielding materials.

References

- [1] S. S. Roy, K. Ghosh, M. Meyyappan, P. Giri, *Small* 2025, 21, 2500003.