Interfacial Engineering of Graphitic Carbon Nanofiber Fabric with Magnetic Nanowires for Insulated EMI Shields

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Graphitic carbon nanostructures are widely explored for electromagnetic interference (EMI) shielding due to their high conductivity and tunable polarisation; however, their direct integration into flexible electronics raises concerns about electrical shorting [1-3]. Electrically insulated EMI shielding materials are therefore essential to ensure operational safety, prevent unintended current leakage, and enable reliable integration into next-generation wearable and flexible electronic systems. Herein, we report an interfacially engineered, electrically insulated EMI shielding system based on electrospun and carbonized graphitic carbon nanofibers (CPAN) integrated with nickel nanowires (Ni NWs) and encapsulated within a polydimethylsiloxane (PDMS) matrix. The CPAN network was dip-coated with PEDOT:PSS to tailor interfacial charge distribution and enhance polarization at heterogeneous interfaces, while Ni nanowires establish coupled conductive–magnetic pathways. Structural and spectroscopic analyses (XRD, Raman, XPS, and SEM) confirm graphitic domain formation and uniform nanowire dispersion. Dielectric spectroscopy in the frequency range 10 MHz – 1GHz reveals enhanced interfacial polarization and frequency-dependent permittivity arising from engineered CNF/PEDOT and CNF/Ni interfaces. A two-layer architecture further promotes internal electromagnetic interactions, achieving an EMI shielding effectiveness of 42 dB in the K band region (18-26.5 GHz) at a thickness of 0.8 mm. This work highlights interfacial engineering of graphitic carbon–magnetic hybrids as an effective strategy for safe, flexible, and electrically insulated EMI shielding systems.

References

[1] Sharma, G.K., James, N. R. ACS Appl. Electron. Mater 3 (2021) 4657−4680.
[2] Zhang, X., Jin, G., Liu, Y., Liu Y., Zhang, M., Li, C., Zhang, X., Cao, D., *Adv Compos Hybrid Mater* **8** (2025) 206.
[3] Rajan, A., Solaman, K.S., Ganesanpotti, S., ACS Appl. Mater. Interfaces **15** (2023), 5822−5835.

Figures

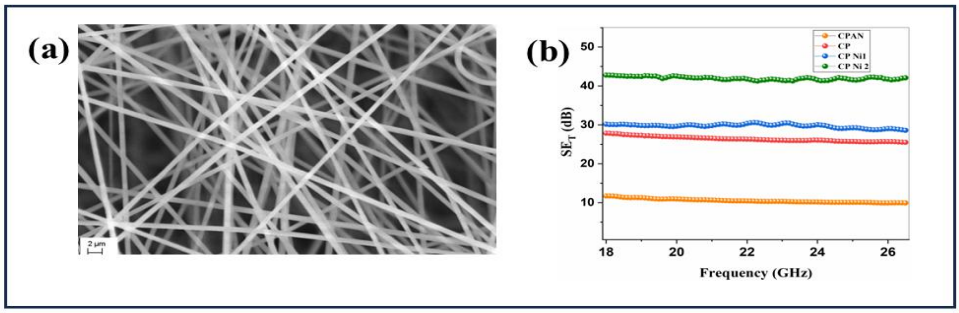

Figure 1: (a) SEM image of the carbonized PAN fibers and (b) EMI SE_T of CPAN, CP, CP Ni 1, and CP Ni 2 in the K band region.