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ADVANCED POLYACRYLONITRILE COMPOSITE NANOFIBERS FOR SMART TEXTILE APPLICATIONS: INTEGRATING MAGNETIC FERRITE NANOPARTICLES

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This study investigates the synthesis and characterization of novel polyacrylonitrile (PAN) composite nanofibers incorporating various magnetic ferrite nanoparticles, including γ -Fe₂O₃, MnZn, Fe₂O₄ and CoFe₂O₄ using electrospinning technique. These electrospun materials are engineered to leverage their unique electronic and magnetic properties for diverse applications in biomedicine, energy, and textiles¹. Our comprehensive analysis, including thermomechanical, morphological, and spectroscopic methods, revealed a key property: a substantial increase in the storage modulus at high temperatures and in some cases under an applied magnetic field, confirming their magnetic responsiveness.

Advanced characterization techniques, such as High-Resolution Scanning Electron Microscopy (HRSEM), X-ray Diffraction (XRD), and Electrochemical Impedance Spectroscopy (EIS), were employed to understand the intricate interactions between the ferrite nanoparticles and the polymer matrix. SEM imaging and Energy-Dispersive X-ray (EDX) mapping confirmed the uniform dispersion of nanoparticles within the PAN nanofibers. Furthermore, EIS data, interpreted with an equivalent circuit model, indicated that the nitrile (CN) groups of PAN play a vital role in anchoring the magnetic nanoparticles via hydrogen bonding and coordination. Notably, the embedded nanoparticles also influenced the polymer's structural integrity by hindering cross-linking while enhancing inter-chain interactions. The demonstrated magnetic field responsiveness and well-dispersed nanoparticles position these composite nanofibers as prime candidates for innovation in smart textiles, wearable electronics, and functional fabrics.

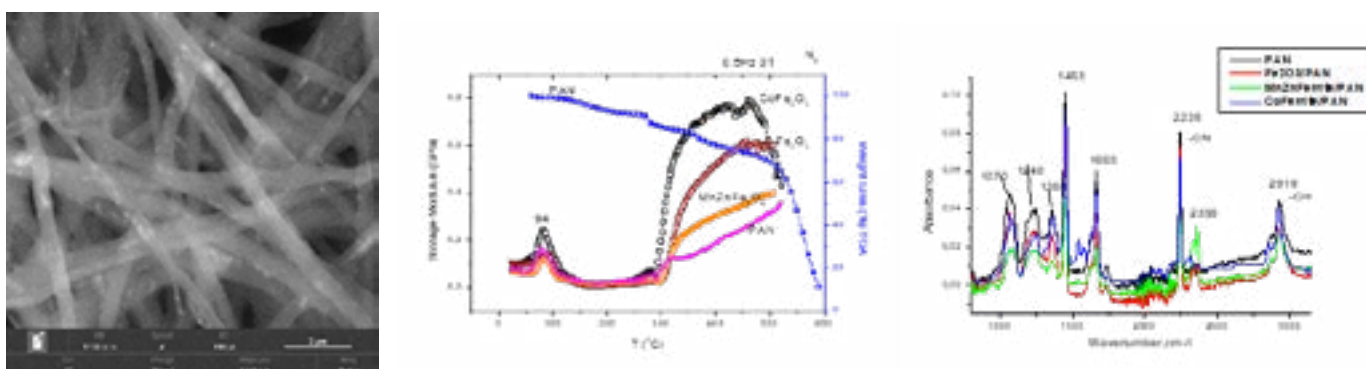


Fig.1. SEM (γ -Fe₂O₃/PAN), Thermomechanical (DMA), & FTIR results of nanofibers

References

- [1] B. Sarac, V. Soprnyuk, G. Herwig, S. Gumrukcu, E. Kaplan, E. Yüce, W. Schranz, J. Eckert, L. Boesel and A. S. Sarac, *Nanoscale Adv.*, 2024,6, 6184-6195, <https://doi.org/10.1039/D4NA00631C>
- [2] B. Sarac, V. Soprnyuk, E. Yüce, S. Gumrukcu, W. Schranz and A. S. Sarac, *Mater. Adv.*, 2025,6, 5475-5485, <https://doi.org/10.1039/D5MA00349K>