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Confined Magnetic Ferrite Nanoparticles in Polyacrylonitrile Nanofibers: Tunable Nanostructures for Tissue Engineering

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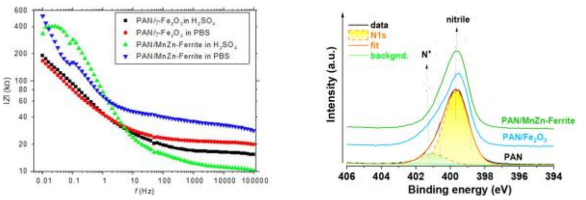
The integration of magnetic nanoparticles into polymer scaffolds has emerged as a promising strategy in tissue engineering, offering the potential for enhanced cell proliferation. In this study, the fabrication and characterization of composite nanofiber membranes composed of ferrite nanoparticles (NPs) and Polyacrylonitrile (PAN), and biocompatible, magnetically active scaffold capable of supporting cellular growth and differentiation was performed. Electrospun PAN Nanofibers embedded Ferrite NPs were characterized using advanced techniques, i.e., FTIR, XPS, HR-SEM, EIS, and XRD [1, 2]. The incorporation of these NPs led to significant changes in the thermal, spectroscopic, and morphological properties of the fibers. Results indicate that the incorporation of MnZn-Ferrite nanoparticles alters the fibers' thermal and morphological properties, enhancing surface chemistry through the formation of new nitrogen functionalities and improved interfacial interactions. Cytocompatibility studies using human mesenchymal stromal cells (hMSCs) revealed no significant impact on cell viability or morphology, confirming the scaffold's biocompatibility. In vitro biological assays using hMSCs demonstrated robust cell attachment and proliferation with no cytotoxic effects, verifying the material's cytocompatibility. By combining the tunable magnetism of MnZn-Ferrites with the mechanical durability of PAN, these scaffolds represent a platform for "smart" regenerative medicine, allowing for non-invasive control over cellular behavior and tissue maturation.



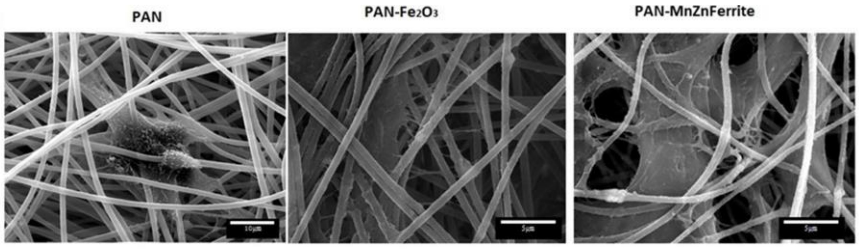


Fig.(a) Bode magnitude plots
(b) XPS N1s of Ferrites-PAN
(c) SEM of hMSC attachment
(48 h of incubation)

References:

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2. Sarac, B.; Soprunyuk, V.; Yüce, E.; Gumrukcu, S.; Schranz, W.; Sarac, A. S. Impact of thermal treatment and magnetic field on the dynamic mechanical behavior of polyacrylonitrile nanofibers with embedded magnetic ferrite nanoparticles. Mater. Adv., 2025, 6, 5475-5485. https://doi.org/10.1039/D5MA00349K