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Green-synthesized CeO_2 nanoparticles loaded electrospun polymeric nanofibers for enhanced bioactivity and biomedical functionality

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Introduction

The development of polymer–metal oxide hybrid biomaterials, which combine the versatility and biodegradability of polymers with the unique properties of metal oxide nanoparticles, opens new avenues in biomedicine. Among metal oxides, CeO_2 nanoparticles stand out for their low systemic toxicity and beneficial effects on living systems. Accordingly, integrating CeO_2 into fibrous polymeric matrices may improve bioavailability and mitigate potential adverse effects, thereby enhancing bioactivity and biomedical functionality.

Objectives

To develop electrospun nanofibers from a polycaprolactone (PCL)/cellulose acetate (CA) blend loaded with green-synthesized CeO_2 nanoparticles and to evaluate their potential to enhance bioactivity and biomedical functionality.

Methodology

1. Green-synthesized CeO_2 nanoparticles

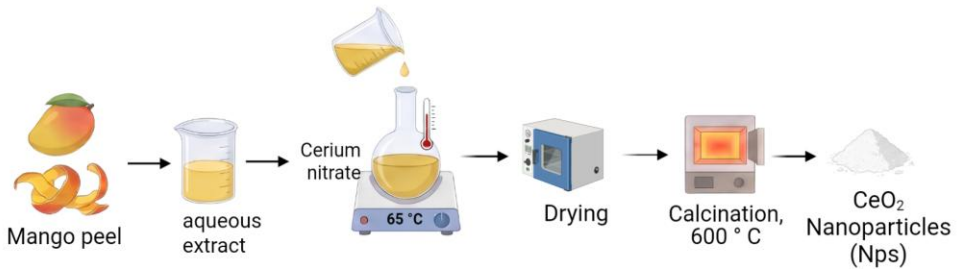


Figure 1. Green synthesis route of CeO_2 nanoparticles using a mango extract-assisted sol-gel method.

2. Electrospinning Process of Fibers

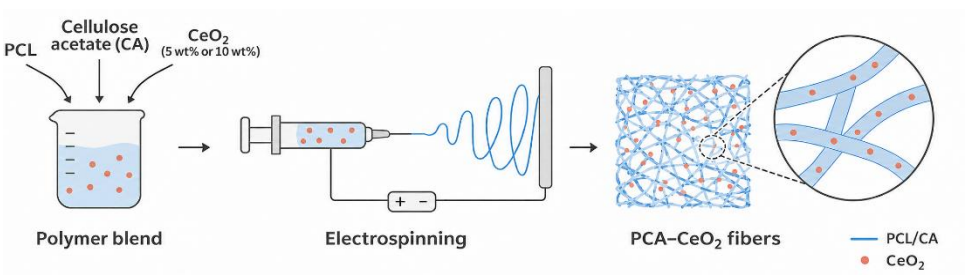


Figure 1. Fiber processing of PCL, PCA, PCA-Ce 5 wt% and PCA-Ce 10 wt%.

Results and Discusion

1. Characterization of nanoparticles

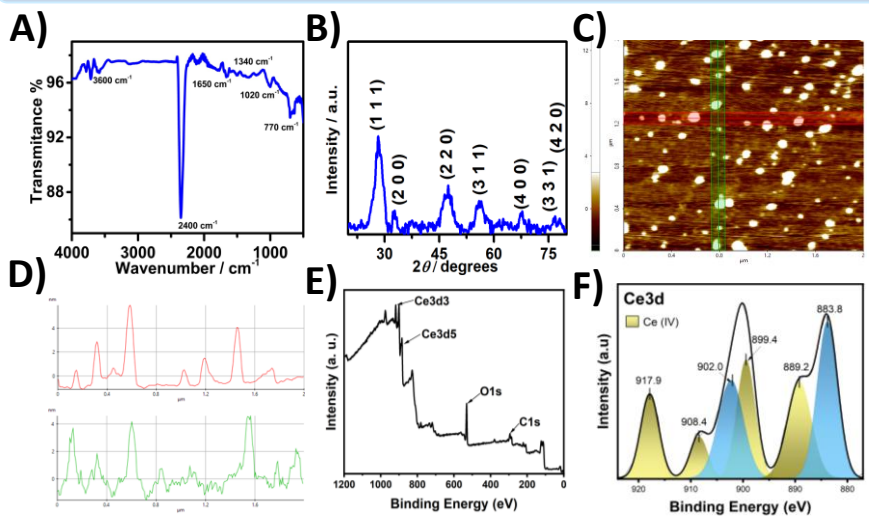


Figura 1. A) FTIR spectrum, B) XRD patterns, C-D) High-resolution AFM surface map , and E-F) XPS spectra of nanoparticles

2. Morphology of fibers

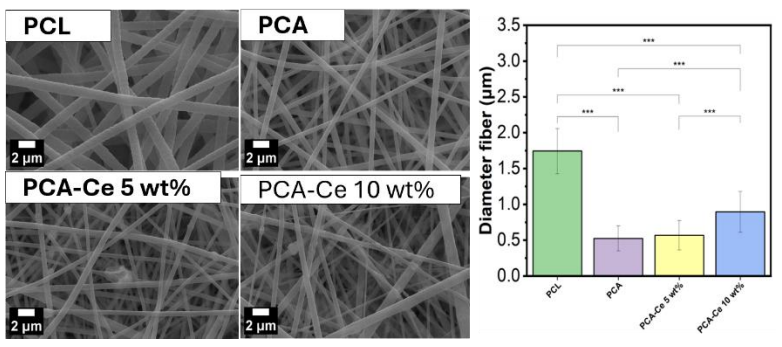


Figura 2. SEM images and Statistical analysis of fiber diameterv(n = 200, *** = $p < 0.001$)

3. In vitro bioactivity and cell viability

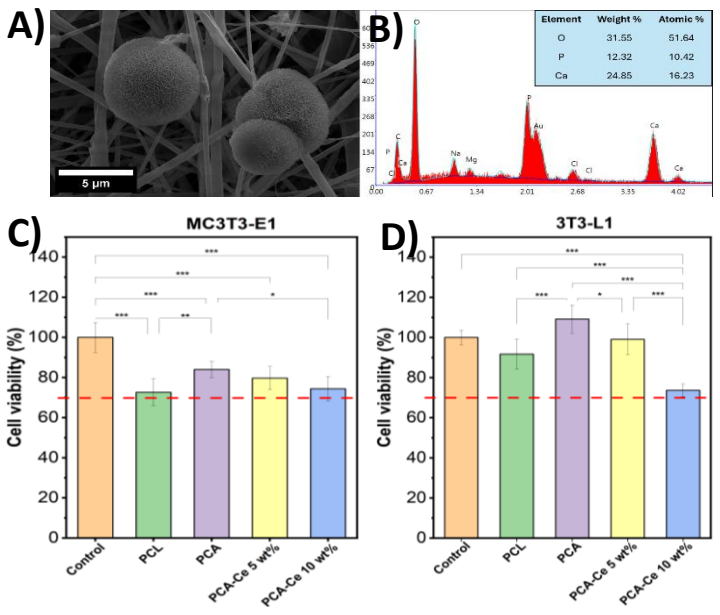


Figura 3. A-B) SEM images and EDS spectra of fibers during 28 days of immersion in SBF solution and **C-D)** Cell viability after 72 h by MTT assays

Conclusions

CeO_2 nanoparticles with an average topographical height of 2.4 ± 0.2 nm and high phase purity were successfully synthesized Electrospun PCL/CA scaffolds incorporating CeO_2 nanoparticles exhibited homogeneous, porous fibers, hydroxyapatite formation within 28 days, and no cytotoxicity in vitro, supporting their potential for biomedical applications.

References and Acknowledgments

1. Strieder, C. D. M.; et al. Plant-Mediated Green Synthesis of Cerium Oxide Nanoparticles: A Critical Perspective of Some Unclear Issues. *Journal of Materials Research and Technology* 2024, 30, 6376–6388.

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