

Abstract

Development and characterization of cpfs synthesized titanium hydroxyapatite composite scaffolds fabricated by 3D printing for biomedical applications

Aneela Anwar* and Sadaf Ameen

Department of Chemistry, University of Engineering and Technology, GT Road, Lahore, Pakistan

* Corresponding author, email: a.anwar@uet.edu.pk

© 2026 Marie Julien; licensee Infinite Science Publishing

This is an Open Access abstract distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (<http://creativecommons.org/licenses/by/4.0>).

Titanium hydroxyapatite (Ti–HA) composites are well known as excellent biomaterials in bone tissue engineering and orthopedic implant applications due to their high mechanical strength, corrosion resistance, and good bioactivity. This study aimed to synthesize Ti–HA composites with uniform particle size using the Continuous Plastic Flow Synthesis (CPFS) method [1,2], which benefits from high crystallinity and homogeneous particle distribution.

Porous scaffolds are fabricated by 3D printing to control the geometry, pore size and porosity of the synthesized composites for bone regeneration. The scaffolds displayed highly interconnected porous structures that bear close resemblance to cancellous bone thereby favoring the attachment of cells as well as transporting molecules leading to an extensive nutrient transfer. We demonstrated the formation of pure crystalline titanium and hydroxyapatite phases as analyzed by X-ray diffraction (XRD). Scanning electron microscopy (SEM) showed uniform and highly porous morphology, energy dispersive spectroscopy (EDS) was used to confirm elemental composition. The presence of hydroxyapatite functional groups was confirmed by Fourier transform infrared spectroscopy (FTIR). Mechanical tests showed mechanical properties of scaffolds as adequate compressive strength and structural stability necessary for bone regeneration. The addition of hydroxyapatite improved bioactivity and osteoconductivity, leading to a better interaction with surrounding bone tissue. These results demonstrate that CPFS combined with 3D printing provides an efficient and scalable approach for developing mechanically stable, highly porous, and biologically active Ti–HA scaffolds for bone tissue engineering applications. This approach provides potential insights into Ti–HA scaffolds that could be useful in bone tissue engineering and regenerative medicine. This work supports several United Nations Sustainable Development Goals (SDGs), including SDG 3 (Good Health and Well-Being) through improvement of biomedical implant materials, SDG 9 (Industry, Innovation and Infrastructure) by enabling advanced manufacturing technologies and SDG 12 (Responsible Consumption and Production) fostering resource-efficient sustainable material synthesis.

AUTHOR'S STATEMENT

Conflict of interest: The authors declare no conflict of interest. Animal models: Not applicable. Informed consent: Not applicable. Ethical approval: The research does not involve human participants or animal experiments. Acknowledgments: The authors acknowledge the support of the Department of Chemistry, University of Engineering and Technology, Lahore. Research funding: The authors state no funding involved.

REFERENCES

- [1] Anwar, A. (2014). Continuous plastic flow synthesis and characterization of nanoscale bioceramics (Doctoral dissertation, UCL (University College London))
- [2] Anwar, A., Rehman, I. U., & Darr, J. A. (2016). Low-temperature synthesis and surface modification of high surface area calcium hydroxyapatite nanorods incorporating organofunctionalized surfaces. *The Journal of Physical Chemistry C*, 120(51), 29069-29076.
- [3] Haleem, A., Javaid, M., Khan, R. H., & Suman, R. (2020). 3D printing applications in bone tissue engineering. *Journal of clinical orthopaedics and trauma*, 11, S118-S124.