Transactions on Additive Manufacturing Meets Medicine
Trans. AMMM, 2026, Vol. 8, No 1, Suppl. 1, Article ID 2970, 1 Page

Infinite Science Publishing

Abstract

3D printing of multi-material and multifunctional contact lenses

H. Butt

Department of Mechanical & Nuclear Engineering, Khalifa University, Abu Dhabi, UAE
* *Corresponding author, email: haider.butt@ku.ac.ae*

3D printing plays a crucial role in medical engineering and has seen continuous growth recently. It provides significant benefits across a range of applications, from prostheses and soft implants to tissue-engineering matrices. Hydrogel-based soft contact lenses are widely used for cosmetic purposes or vision correction, typically made from customized hydrogel composites that provide high water content for comfort, softness, and oxygen permeability [1,2]. A popular research area involves functionalizing contact lens surfaces with dyes, coatings, and nanoparticles to improve optical filtering, enable self-hydration, and enhance antioxidant, antibacterial, and drug delivery functions [3,4].

Additive manufacturing (also called 3D printing) enables the versatile production of custom contact lenses with specific shapes, sizes, and spectral properties [1, 4]. Successful 3D printing of contact lenses requires careful optimization of many parameters, including exposure time, layer thickness, resin composition, and post-processing [4]. To aid this process, AI models were trained to design lenses' optical properties inversely by linking resin types, dye levels, lens geometry, and optical transmission spectra [5,6]. The Multilayer Perceptron [6] outperformed other models in predicting resin compositions from optical spectra, while the Random Forest model excelled at reconstructing spectra from known resin inputs [6].

The optical transmission characteristics of the AI-engineered 3D-printed contact lenses matched the predictions from the machine learning models. This research shows that combining machine learning with material analysis allows for data-driven design of 3D-printed wearable photonic devices, providing both mechanical stability and customizable spectral features [6]. It opens the door for future digital manufacturing of personalized wearable devices [7].

AUTHOR'S STATEMENT
Conflict of interest: Authors state no conflict of interest. Acknowledgments: This research was funded by Khalifa University of Science and Technology through the Research Innovation Grant (RIG), Project ID KU-INT-RIG-2024-8474000736, and the Advanced Digital & Additive Manufacturing (ADAM) Research Group (Award No. 8474000163).

REFERENCES

[1] F. Alam, 3D printed contact lenses for the management of color blindness, Additive Manufacturing, vol. 49, pp. 102464, 2022
[2] A. E. Salih, Gold nanocomposite contact lenses for color blindness management, ACS Nano, vol. 15, pp. 4870-4880, 2021
[3] S. E. Turk, Exosome-Loaded Contact Lenses: A Novel Approach for Sustained Ocular Drug Delivery, Nano Select, vol. 6, pp. e70045, 2025
[4] M. Hisham, 3D printing of multimaterial contact lenses, ACS Biomaterials Science & Engineering, vol. 9, pp. 4381-4391, 2023
[5] Y. Xia, State-of-the-art in smart contact lenses for human–machine interaction, IEEE Transactions on Human-Machine Systems, vol. 53, 187-200, 2022
[6] M. Elnemr, Machine-Learning-Guided design and inverse engineering of 3D-printed optical filters, Materials & Design, vol. 264, pp. 115782, 2026
[7] M. M. Syed, Mapping Smart Contact Lens Research: Thematic Analysis of Trends, Current Challenges and Future Directions, Engineered Science, vol. 39, 2025

DOI: 10.18416/AMMM.2026.26062970