Egyptian Prosthodontic Association
(EPA Newsletter)

Selection criteria for Dental 3D Printing Resin

Electronic Newsletter
Volume 4. Issue 11
November 2025

With the development of technology, production technologies for dental restorations are developing in an insignificant way. 3D printing has become a key player in dental field, facilitating the production of variety of options starting from cast production, till the production of final definitive restorations.

For printing three dimensional parts using multifunctional composites, photopolymer resins have been utilized. Dental resins, including methacrylate-based ones (such as polymethyl methacrylate or PMMA), epoxy-based ones, and cationic-based ones, can be combined with different fillers, such as glass, carbon, or ceramic fibers and particles. (1)

Methacrylate monomers are frequently used in resin-based composites obtained via photopolymerization. These monomers form an organic matrix that has a high reactivity and degree of crosslinking. The two most commonly used monomers in dental composites are BisGMA and TEGDMA. (2)

New materials Following rapid development in the 3D printing market, products are constantly being added to ensure the desired performance: Increased print speed, Adherence between structure plate and layers, Improving precision and aesthetics and Low shrinkage and dimensional stability. They appear in the form of features. High performance materials, high mechanical strengths and thermal properties as well as functional prototypes and small series production parts meet the demands of the demanded applications (3).

Criteria for Dental 3D Printing Resin Selection.

1- Biocompatibility

The biocompatibility of dental printing resins is critical for patient safety and requires resins to be inert, non-toxic, and not elicit an adverse biological response. While many resins are designed to be tissue-friendly, their potential cytotoxicity from residual monomers and photoini tiators necessitates thorough post-processing, including washing, to ensure safety. Factors influencing biocompatibility include the resin's chemical composition, the 3D printing process and post-cure steps, and adherence to regulatory standards

like ISO 10993. (4)

Factors Influencing Biocompatibility

- **Washing Protocols:**

Extended and proper washing of 3D-printed resin samples can significantly improve cell viability by eliminating uncured fractions.

- **Printing Orientation:**

The orientation of the print can influence the surface properties of the resin, which may impact biocompatibility.

- **Post-Curing Methods:**

Proper curing processes are vital for cross-linking the resin's monomers, reducing residual components and improving overall safety.

- **Material Additives:**

The percentage of reinforcing nanoparticles like zirconia or glass silica can improve mechanical properties without compromising biocompatibility, though their concentration needs careful optimization. (5)

2- Mechanical Properties

Understanding these mechanical properties is critical in dentistry and prosthodontics, where materials require specific strength and durability to withstand functional forces

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Key Mechanical Properties for Dental 3D Printing Materials are flexural Strength, compressive Strength, wear Resistance, hardness, and elastic Modulus. (6&7)

Factors Influencing Mechanical Properties

- **Manufacturing Process:**

Different 3D printing technologies (SLA, DLP, LCD) have varying effects on the final mechanical properties, with SLA often showing higher strength and smoothness.

SLA, DLP, and LCD can print complex geometries with high resolution. However, each method has different strengths and weaknesses in mechanical strength and surface quality SLA, known for its high resolution and smooth finishes, is frequently preferred for applications requiring fine detail and high strength. DLP balances speed and quality, making it suitable for rapid prototyping. While more cost-effective, LCD printing is often criticized for producing restoration with higher surface roughness owing to pixelation, which may require additional post-processing for applications requiring smooth surfaces. (8,9,10)

- **Printing Direction:**

The orientation of layers during printing can significantly impact strength, as the bonds between layers can be weaker than bonds within a layer. (8)

- **Post-Processing:**

Techniques like post-curing and surface treatments can improve the mechanical properties and surface quality of 3D-printed dental parts. (7)

- **Material Composition:**

The type of resin or composite used plays a major role, with variations in fillers and polymer matrix affecting properties like flexural strength and wear. (11)

3- Accuracy

The accuracy of dental 3D printing resins is generally within a clinically acceptable range for various applications, with many studies showing internal accuracies around 17-52 µm for restorations, comparable to milling methods, though this can vary with different resins, printer technologies (SLA/DLP), print parameters like layer thickness, and crucial post-processing steps. Factors like support structures, internal model design, and surface finish also influence the final dimensional accuracy. (12)

Key Factors Influencing Accuracy

Resin Type and Quality:

The type of photosensitive resin and its quality directly impacts print accuracy. (12)

Printer Technology:

Different technologies like SLA and DLP have varying accuracies; however, both can achieve clinically acceptable results. (9)

Print Parameters:

Layer Thickness: Thinner layers (e.g., 25 µm) can sometimes lead to greater deviation, while thicker layers (e.g., 100 µm) may show fewer deviations. (13)

Post-Processing:

Proper post-processing, including washing, support removal, and secondary light-curing (post-curing), is vital for achieving the material's full potential accuracy. (12)

Finaly these criteria are crucial in case of selection of resin , as this affects the accuracy and mechanical properties of 3d printed restorations, and hence the longevity of restorations inside the oral cavity. The oral conditions can be detrimental for the success of treatment and final patient satisfaction. (13)

References

1- Palmero EM, Bollero A. 3D and 4D Printing of Functional and Smart Composite Materials. In Encyclopedia of Materials: Composites. Amsterdam, The Netherlands: Elsevier Inc. 2021; 402–419.

2- Topa M, Ortyl J. Moving Towards a Finer Way of Light-Cured Resin-Based Restorative Dental Materials: Recent Advances in Photoinitiating Systems Based on Iodonium Salts. Materials. 2020; 13(18): 4093.

3- Akdoğan Eker A. Selection criteria of materials used in 3D printers. Proc Eng Sci [Internet]. 2019 Jun;1(2):47. Available from: https://doi.org/10.24874/PES01.02.047

4- Fugolin AP, Pfeifer CS: New resins for dental composites. J Dent Res. 2017, 96:1085-91. 10.1177/0022034517720658.

5- Parkash J, Shenoy M, Alhasmi A, Al Saleh AA, Shivakumar GC, Shivakumar S. Biocompatibility of 3D printed Dental Resin :A systematic review.2024;16:e15721.

6- Zaim B, Serin Kalay T, Purcek G. Friction and wear behavior of chairside CAD-CAM materials against different types of antagonists: An in vitro study. J Prosthet Dent. 2022;128(4):803-813.

7- Alageel, O. et al. Trueness, flexural strength, and surface properties of various three-dimensional (3D) printed interim restorative materials after accelerated aging. *Polymers (Basel)* **15**(14), 3040 (2023).

8- Milde, J. The component in digital light processing technology: Influence of selected photopolymers on the resulting accuracy and surface roughness. In *Annals of DAAAM and Proceedings of the International DAAAM Symposium* 235–245. (DAAAM International Vienna, 2021).

9- Simeon, P. et al. Wear resistance and flexural properties of low force SLA- and DLP-printed splint materials in different printing orientations: An in vitro study. *J. Mech. Behav. Biomed. Mater.* **152**, 106458 (2024).

10- Brighenti, R., Cosma, M. P., Marsavina, L., Spagnoli, A. & Terzano, M. Laser-based additively manufactured polymers: A review on processes and mechanical models. *J. Mater. Sci.* **56**(2), 961–998 (2021).

11- Dionysopoulos D, Gerasimidou O. Wear of contemporary dental composite resin restorations: a literature review. Restor Dent Endod. 2021 Feb 25;46(2):e18.

12- Alammar A, Att W, Beuer F. The Accuracy of 3D-Printed Fixed Dental Restorations. J Esthet Restor Dent. 2025 Apr;37(4):1047-1061. doi: 10.1111/jerd.13365.

13- Ahayeri A., Morgan M., Fugolin A.P., et al. 3D printed versus conventionally cured provisional crown and bridge dental materials. Dent. Mater. 2018;34:192–200.

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