

Flexural Strength of a 3D-Printed Resin on Recommended and Non-Recommended Printers

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Introduction

3D-printed material is a relatively new option for dental restorations. Due to their typical lower strength and durability than ceramics, they have been used primarily for temporary restorations. However, newer 3D printed-resin composites now claim they can be used for definitive restorations in both fixed and removable applications.

Flexcera Smile Ultra+ 3D-printed resin is a composite resin designed for artificial teeth. 3D-printed composites like this are composed of a polymer matrix, typically methacrylate or acrylate resins, blended with ceramic particles like barium glass of silica.² This combination increases mechanical strength but also increases brittleness. Indications for use include denture teeth, definitive crowns, inlays, onlays, veneers and temporary bridges. This material specifies that it must be used with specific printers, including the recommended Desktop Health 3D printer.

Objectives

This study evaluates the mechanical behavior of Flexcera Smile Ultra+ 3D-printed resin for restorations using a three-point flexural test. The material was printed using both the recommended Desktop Printer (DP) and non-recommended Straumann P30 Printer (SP). Additionally, the effects of material expiration and thermal cycling were assessed.



Straumann P30 Printer (L) and Desktop Health Printer (R)

Materials and Methods

Sixty bar-shaped samples (64 x 10 x 3 mm) were printed (n=10/group). On the recommended printer (DP), samples with thermocycling and without thermocycling were tested (5,000 thermal cycles between 5°C and 55°C). On the non-recommended printer (SP), non-expired samples were tested with and without thermocycling, and expired samples were tested with and without thermocycling.

Samples were printed, polished with the same polishing protocol, and labeled. The samples were tested for flexural strength using a universal testing machine 3-point test, and data was analyzed with three-way ANOVA and post hoc tests to evaluate the effects of printer type, thermal cycling, and expiration.

Printer Types

- Samples were printed on Straumann P30 Printer (DLP printer) and Desktop Health Printer (SLA printer)
- Digital Light Processing (DLP) works by using a light projector to cure resin in layers
- Stereolithography (SLA) works by using laser light to cure resin

Sample Polishing

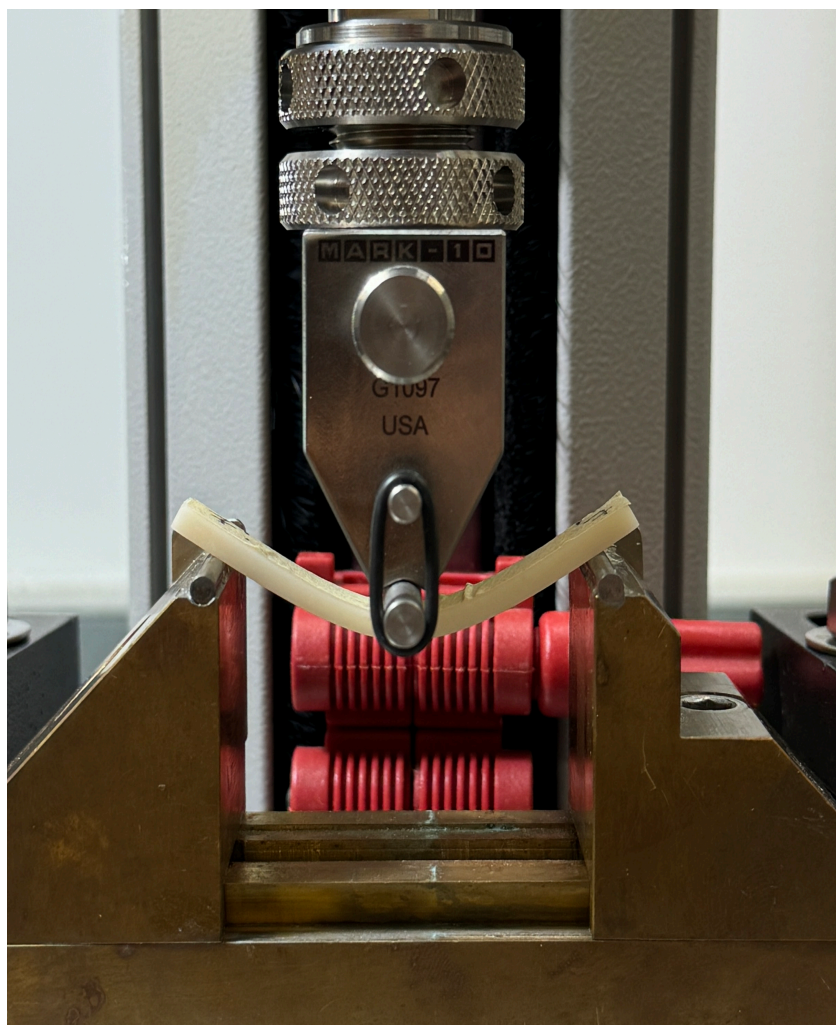
- Samples were polished to simulate lab polishing protocols
- Samples were polished by hand using 3 grit levels (Course, Fine, Flour) of laboratory pumice (Henry Schein Laboratory Pumice) and wet-wheel

3-Point Test

- Samples were tested using the ISO standard for general polymer
- Load cell: 2500 N, Span: 50 mm, Speed 5.0 mm/min



Samples from Straumann Printer (64mm x 10mm x 3mm)



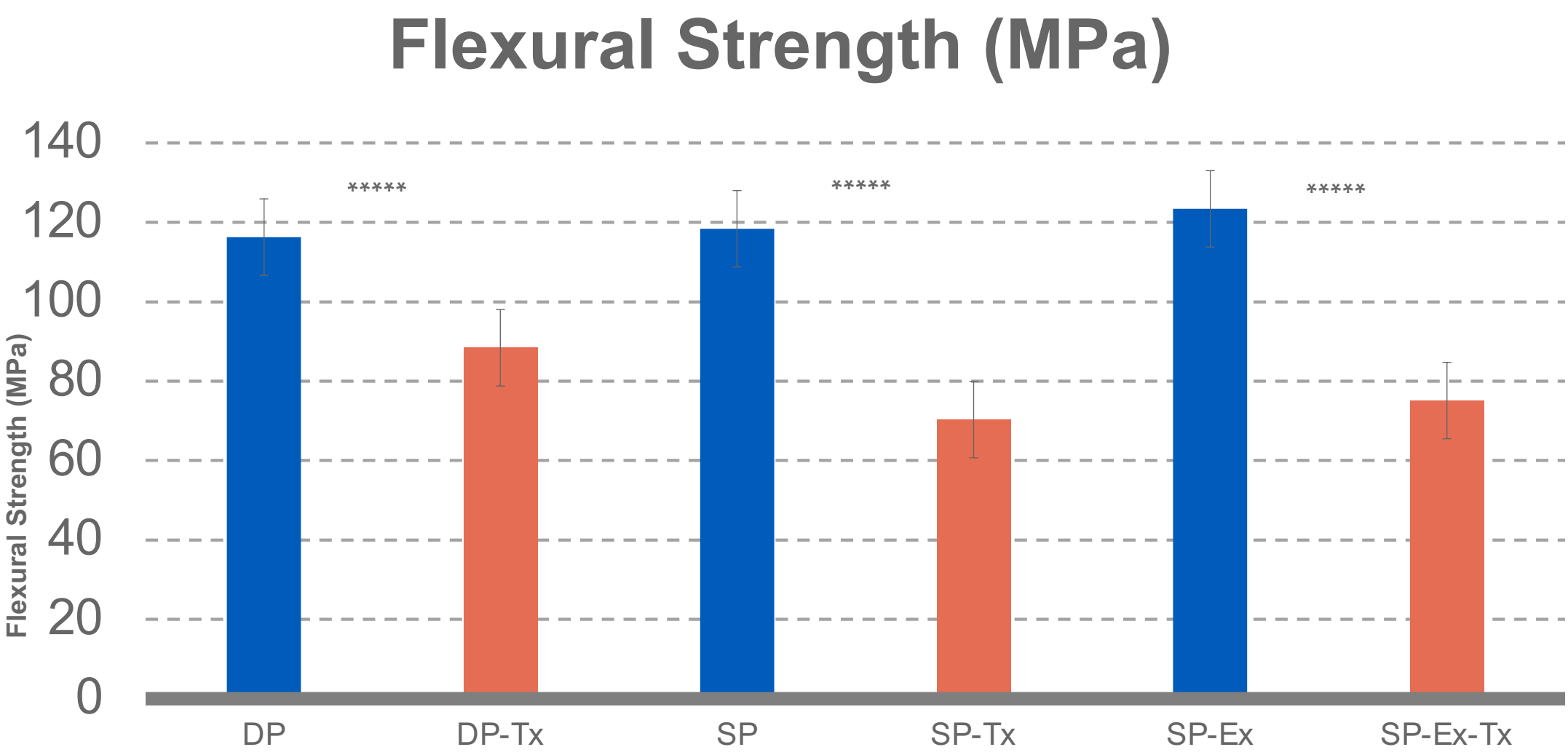
Thermocycling (L) and 3-point test on the Universal Testing Machine (R)

Results

All materials met the ISO standard of 65 MPa for flexural strength. Samples printed on the SP showed similar flexural strength to those on the DP (P>0.05), regardless of expiration status. However, thermocycling significantly reduced flexural strength (P<0.05) in both expired and non-expired samples printed on the SP.

Table 1 – Desktop Health Printer - Recommended			
	Slope (N/mm)	Flexural Strength (MPa)	Flexural Modulus (MPa)
DP	24.50	116.66	2963.56
DP-Tx	19.29	82.93	2146.60

Table 2 – Straumann Printer - Non-Recommended			
	Slope (N/mm)	Flexural Strength (MPa)	Flexural Modulus (MPa)
SP	27.02	118.37	3118.38
SP-Tx	16.39	70.30	1837.25
SP-Ex	27.90	69.41	2168.01
SP-Ex-Tx	16.71	74.90	2023.69



Conclusion

Flexcera Smile Ultra+ printed on the non-recommended Straumann P30 printer exhibited similar flexural strength to those printed on the recommended Desktop printer, though thermocycling negatively impacted strength in all groups.

Despite thermocycling and expiration negatively impacting strength, all samples still reached the ISO standard of 65 MPa on the non-recommended printer.

Future research should expand on this by testing other 3D-printed materials and investigating other mechanical properties on both types of printers.

References

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2. Sartori, N., Sanchez, S. A., Oliveira, D., Hosney, S., Zoidis, P., Martin, W., Gonzaga, L., & Rocha, M. G. (2024). Flexural properties and fatigue limit of 3d-printed and milled resin-based materials. *Journal of Prosthodontics*. <https://doi.org/10.1111/jopr.13837>