

The effect of common denture cleaners on the microhardness, color, translucency, flexural strength and modulus of 3D-printed denture base resin containing zirconium oxide nanoparticles

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INTRODUCTION

3D-printed denture base materials have inferior properties compared to both traditional and milled dentures.¹ Moreover, chemical cleaners worsen these properties over time. The addition of **silanized nanoparticles (NPs)** such as **zirconium dioxide (ZrO₂)** to both PMMA and to 3D-printed denture base resins has been shown to improve physical and mechanical properties, while minimizing negative optical and surface properties.²

The purpose of this in vitro study was to investigate the impact of common denture cleaners on the physical, surface, and optical properties of 3D-printed denture base resins modified with ZrO₂NPs.



Figure 1. Specimens were soaked in control and experimental solutions (above) in a beaker with marble weights.



METHODS

- Silanized ZrO₂NPs were incorporated into **0%, 1%, and 3%** resin solutions (% w/w).
- Cylinders (**15x2mm**) were generated for evaluating microhardness, color, and translucency (n=90).
- Rectangular prisms (**25x2.5x2mm**) were fabricated to test flexural strength and modulus (n=120).

- Heat-activated denture base acrylic resin served as control.
- One year simulated exposure to effervescent denture cleaner or diluted sodium hypochlorite**, with deionized water used as control.
- Measurements were recorded **before and after exposure** to cleaners. Statistical analyses included two-way ANOVA and pairwise comparison.

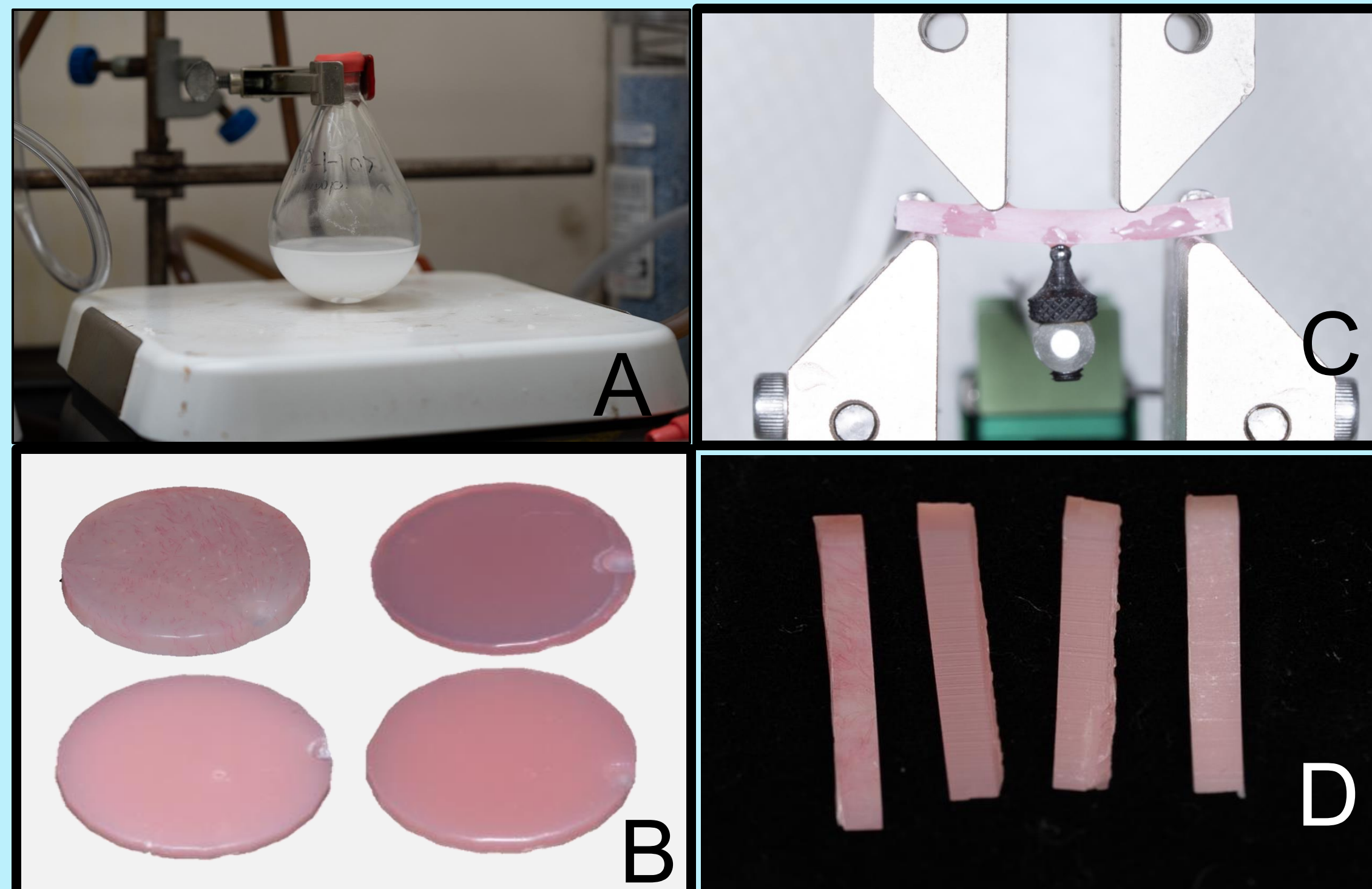


Figure 2. **A**, NP silanization process. **B**, Cylindrical samples (clockwise from upper left): Lucitone 199, 0% Printed, 1% Printed, 3% Printed. **C**, 4-point bend test. **D**, Prism samples (from left to right): Lucitone 199, 0% Printed, 1% Printed, 3% Printed.

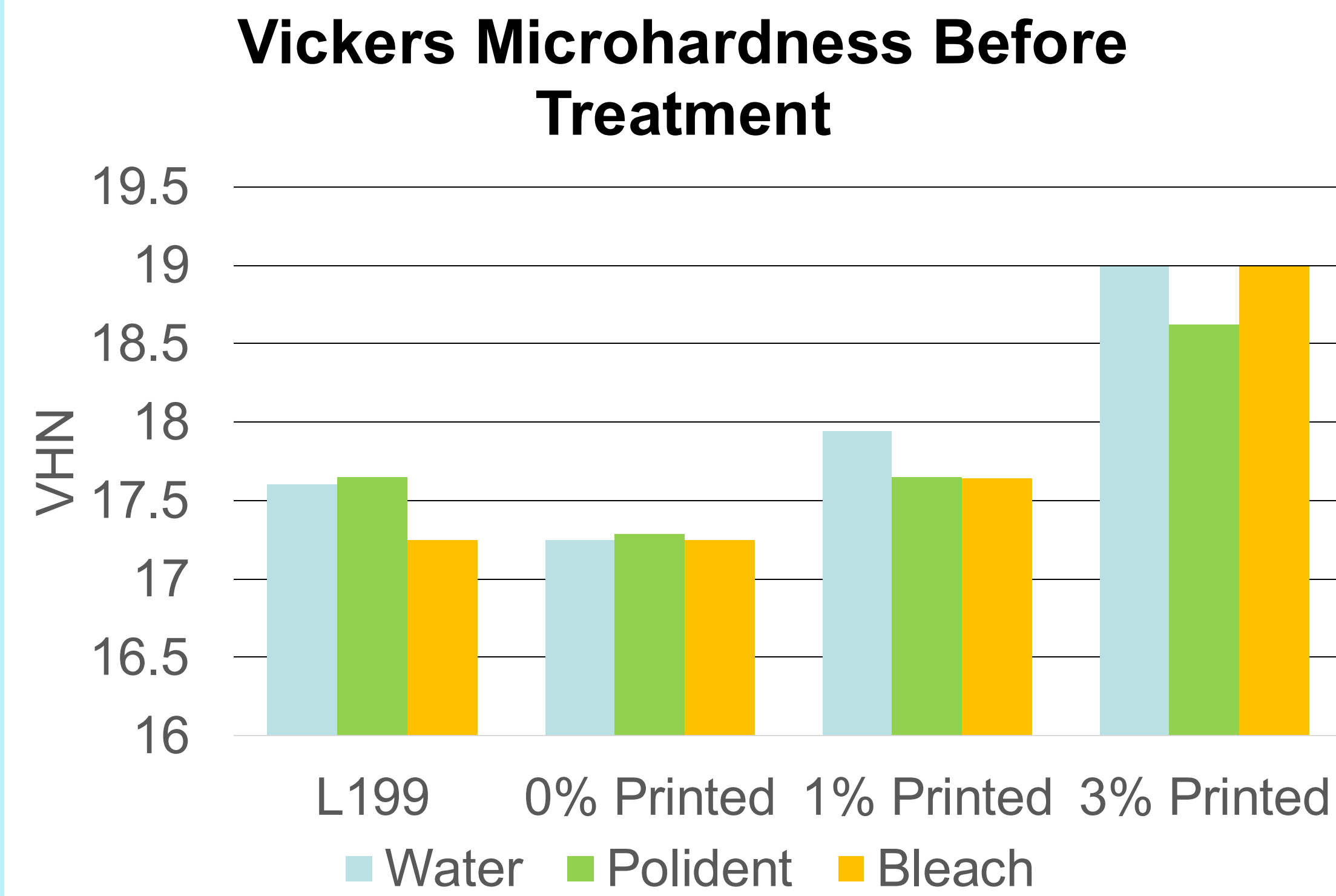


Figure 3. ZrO₂NPs significantly increased microhardness in ALL pre-treatment groups. Both material and treatment significantly affected the amount of “softening.”

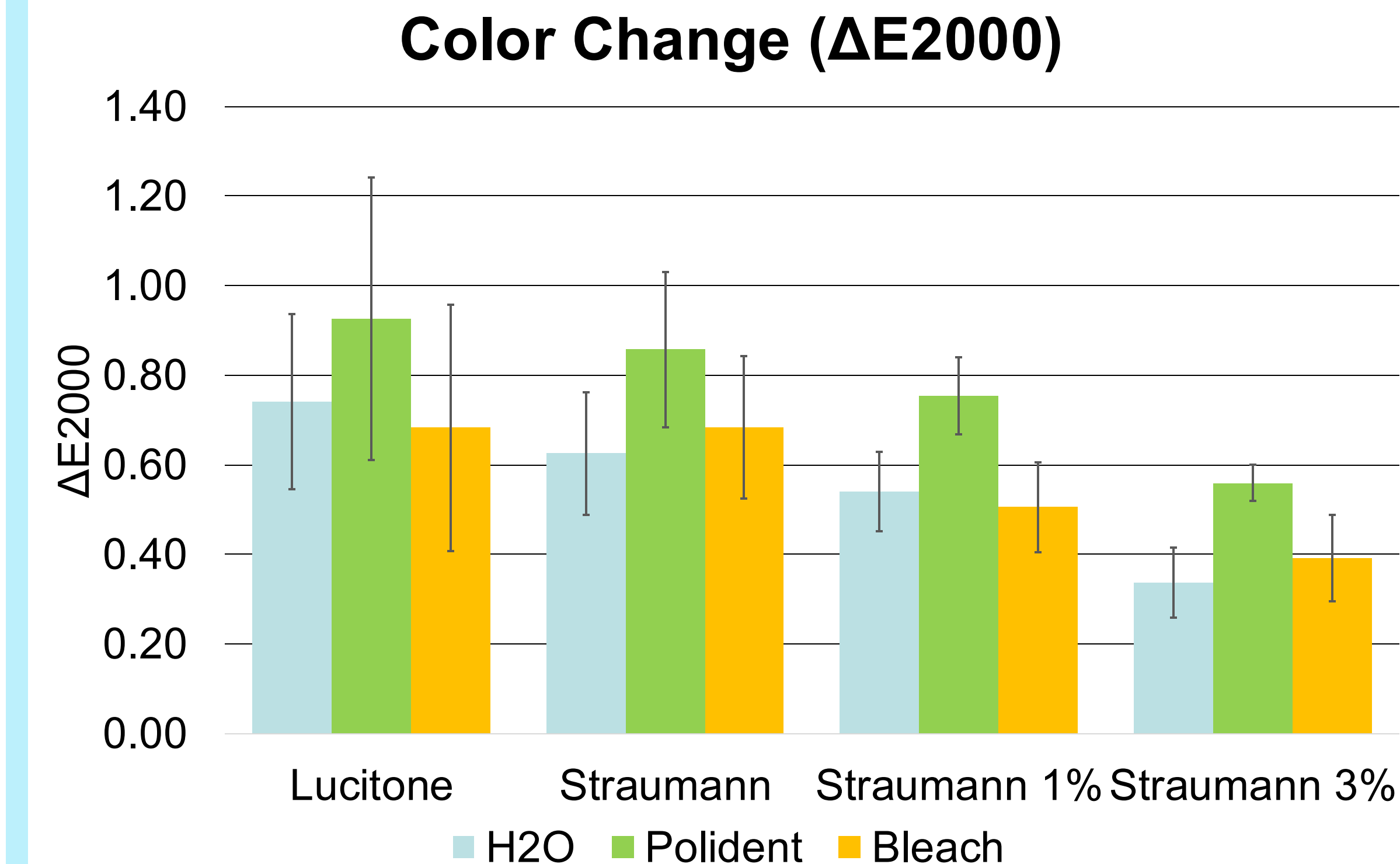


Figure 4. Both material and treatment significantly affected amount of color change (ΔE), with effervescent cleaner causing more color change than NaOCl.

Treatment		dTP2000
L199	water	0.284±0.414 BC
	cleaner	0.375±0.520 BC
	bleach	0.440±0.480 BC
0%	water	0.302±0.691 BC
	cleaner	1.064±0.835 A
	bleach	0.294±0.490 BC
1%	water	-0.010±0.418 C
	cleaner	0.607±0.629 AB
	bleach	0.209±0.514 BC
3%	water	0.021±0.530 C
	cleaner	0.446±0.632 BC
	bleach	0.080±0.615 BC

Figure 5. Translucency parameter (ΔTP) was significantly affected by treatment, but NOT by addition of ZrO₂NPs. Different capital letters indicate statistical significance.



Figure 6. Example of fractured specimen.

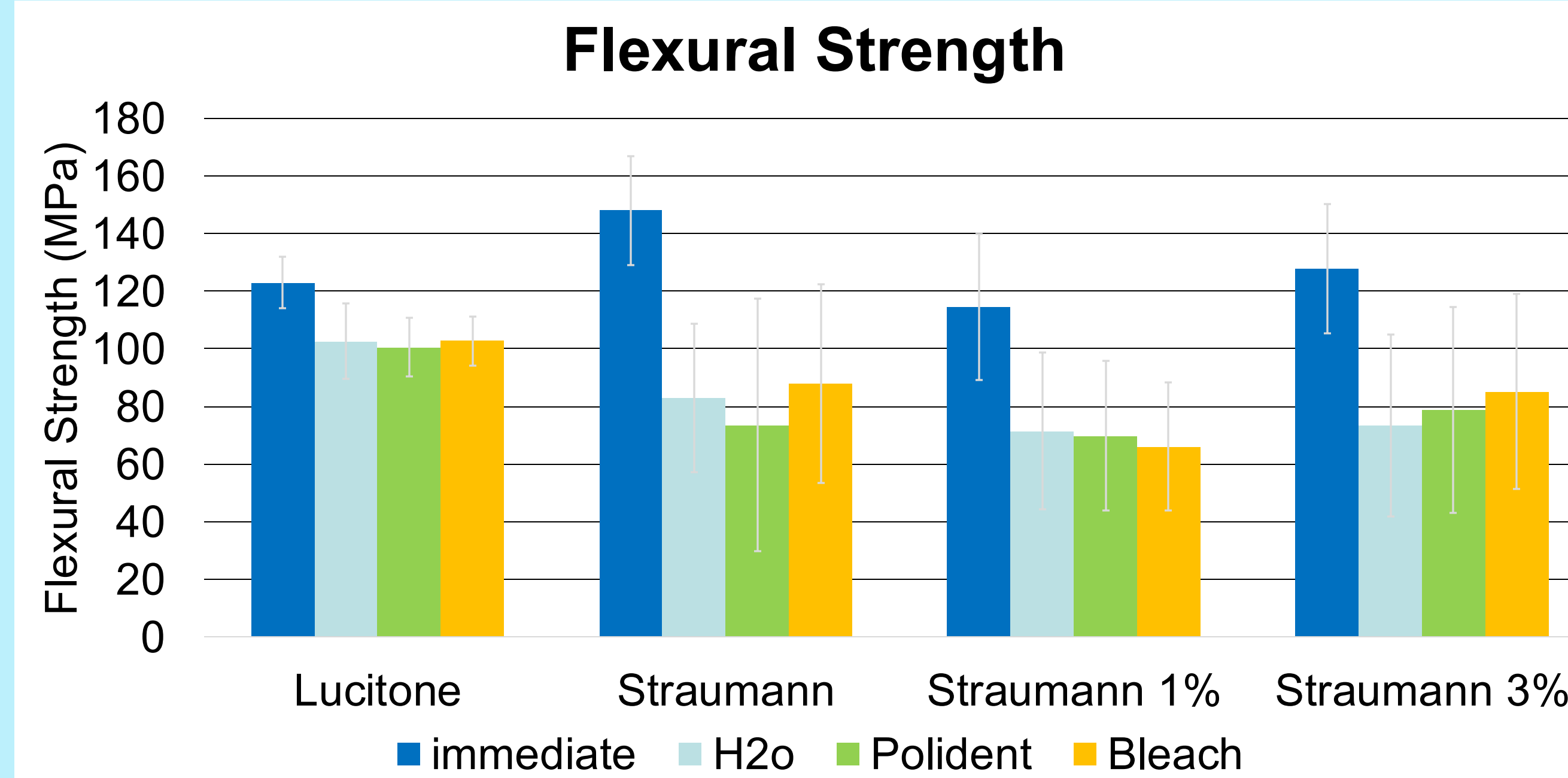


Figure 7. Compared to control resin, flexural strength significantly decreased for all 3D-printed resin groups.

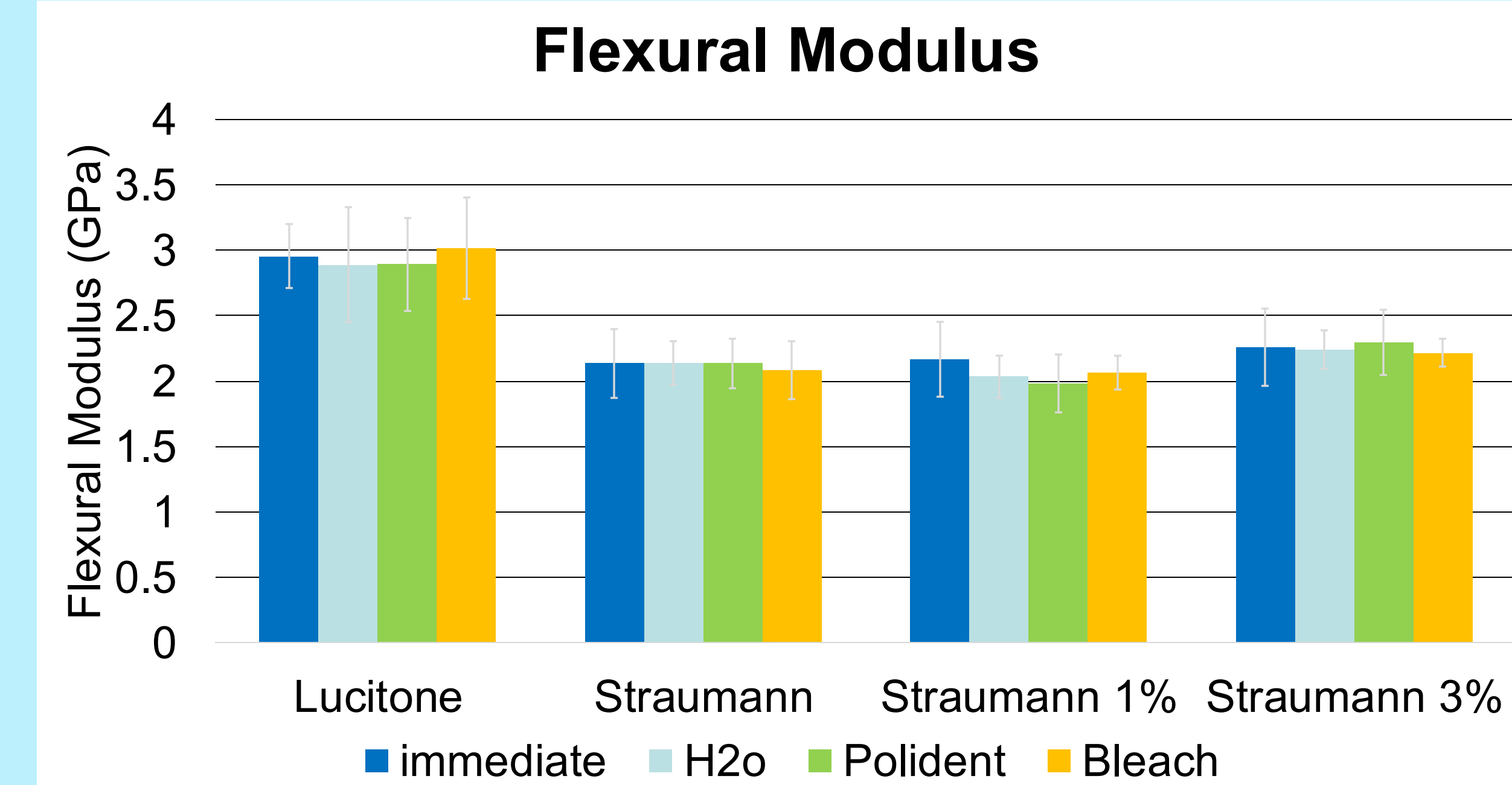


Figure 8. Control specimens exhibited a statistically significant increase in flexural modulus as compared to 3D-printed resins, which were not significantly affected by the cleaners.

CONCLUSIONS

- Addition of ZrO₂NPs increased microhardness without clinically significant susceptibility to color (ΔE<1) and translucency (ΔTP<0.62) change.**
- Although increased % w/w ZrO₂NPs did not reveal a dramatic effect on flexural strength or modulus, their incorporation did not worsen mechanical properties compared to control.**

ACKNOWLEDGMENTS

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