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WHITE PAPER
POLYJET

Research demonstrates the color stability of Stratasys® TrueDent™ Polymers.

New manufacturing polymers for creating removable and fixed dental prostheses, including crowns and dentures, are being introduced to dentists and their patients at an unprecedented rate. An important property of dental prostheses is that they maintain their color properties, or color stability, as the staining and darkening of teeth over time may lead to patient dissatisfaction or rejection of dentures. To ensure a patient's acceptance and aesthetic satisfaction, the polymers used to manufacture dental prostheses must maintain their color stability even as they are exposed to liquids like coffee, and wine.

In 2023, Dr. John A. Sorensen, DMD, PhD, FACP, a professor in the Department of Restorative Dentistry and Director of Research for the Graduate Prosthodontics Program at the University of Washington and his colleague Dr. Marwan Fattouhi and Lee Culp, CDT conducted a study to evaluate the color stability (stainability) of additive and subtractive computer assisted manufacturing (CAM) polymers compared to a manufactured denture tooth control when immersed in chromogenic staining solutions of wine and coffee with water as a control and measured periodically.

This study provides evidence that dental prostheses manufactured with TrueDent™ resin have the needed color stability to provide dentists and their patients with a reliable, highly aesthetic choice for permanent dentures and temporary crown and bridges.

Material and Methods

In the study, researchers evaluated nine different additive and subtractive computer assisted manufacturing (CAM) polymers used to create dental prostheses, including Stratasys TrueDent and TrueDent Glossy which is printed with a glossy surface. A prefabricated IPN denture tooth from Dentsply Sirona was used as a control. Researchers studied the color stability of the polymers and the control when immersed in chromogenic staining solutions of wine (Syrah) and coffee, with distilled water used as a control.

Samples of each material were immersed into three standardized solutions of coffee, red wine, and distilled water at 40+1°C with constant stirring. The degree of color change was monitored over time with measurements made before immersion and at 1, 2, 3, 6, 8 and 10 weeks. A portable color analyzer was used to measure the CIELAB values of each specimen 3 times and color differences (ΔE) calculated. Two-Way ANOVA and Tukey post-hoc test was used for comparisons ($p<.05$).

Table 1. Prosthodontic polymer material systems tested.

Code	Brand	Manufacturer	Composition	Fabrication System
DNT	Denture Tooth Material	Dentca	Methacrylate-based photopolymerized resin	Printed
FLX	Flexcera Smile Plus	Desktop Health	Methacrylated oligomers	Printed
IPN	IPN Denture Tooth	DentsplySirona	Crosslinked PMMA	Factory
IVO	Ivotion	Ivoclar	Highly cross-linked PMMA tooth material	Milled
ONX	OnX*	SprintRay	Nanoceramic hybrid	Printed
TRU **TRG**	TruDent Denture Tooth Material Version 1. Standard surface Version 2. Glossy printed surface	Stratasys	Methacrylate-based resin	Polyjet printed
TSN	Trusana	Myerson	Methacrylated oligomers	Printed
VAR	VarseoSmile Crown Plus*	Bego	Ceramic filled hybrid resin	Printed
VIV	SR-Vivodent DCL Milling Disk	Ivoclar	Highly crosslinked PMMA	Milled

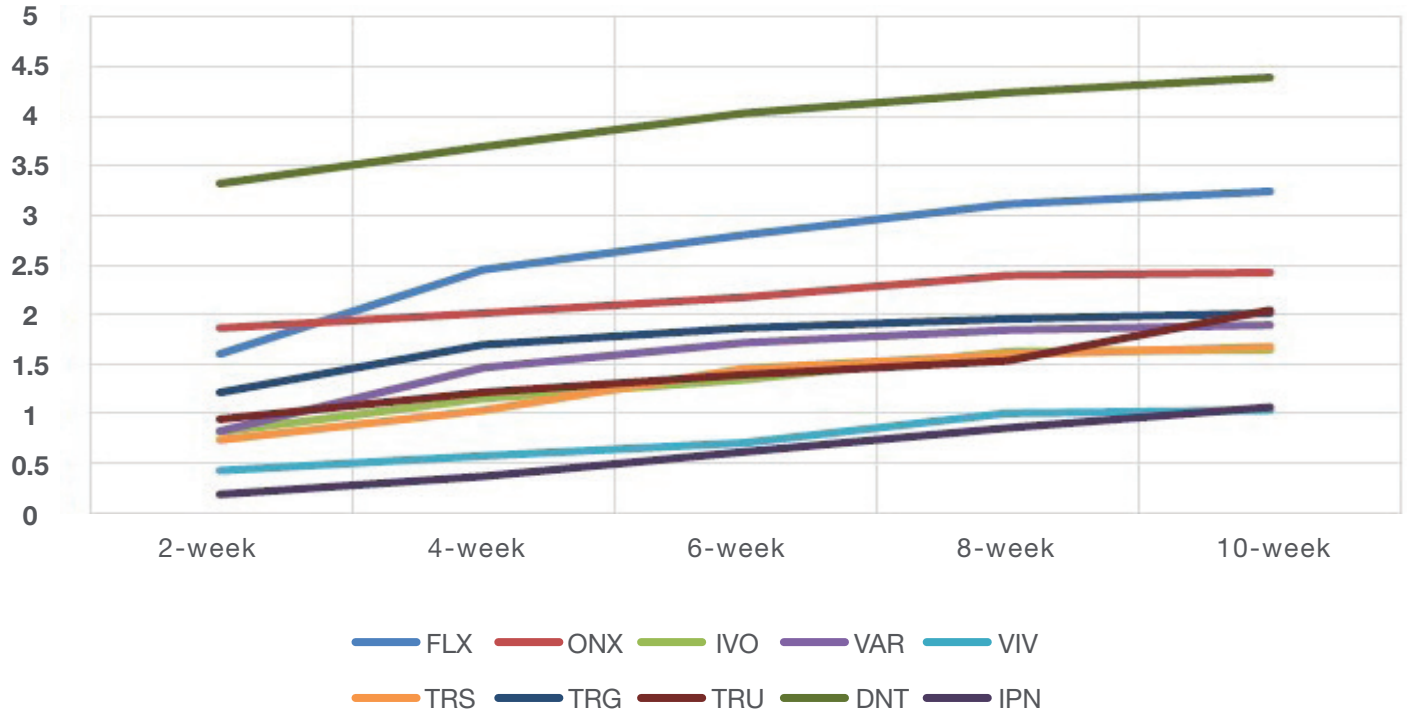
*Varseo Smile Plus and OnX are sold as "permanent" crown material.

Results

SR-Vivodent and Ivotion demonstrated the lowest overall ΔE values while Flexcera and Dentca had the highest. In control water solution, mean ΔE of Dentca was significantly higher than the control. For coffee solution- Flexcera, OnX, and Dentca exhibited significantly higher mean ΔE than the control. In the wine solution, the mean ΔE of Flexcera and Dentca were significantly higher while SR-Vivodent was significantly lower than the control. TrueDent and TrueDent glossy showed a similar average change in color to the control denture tooth.

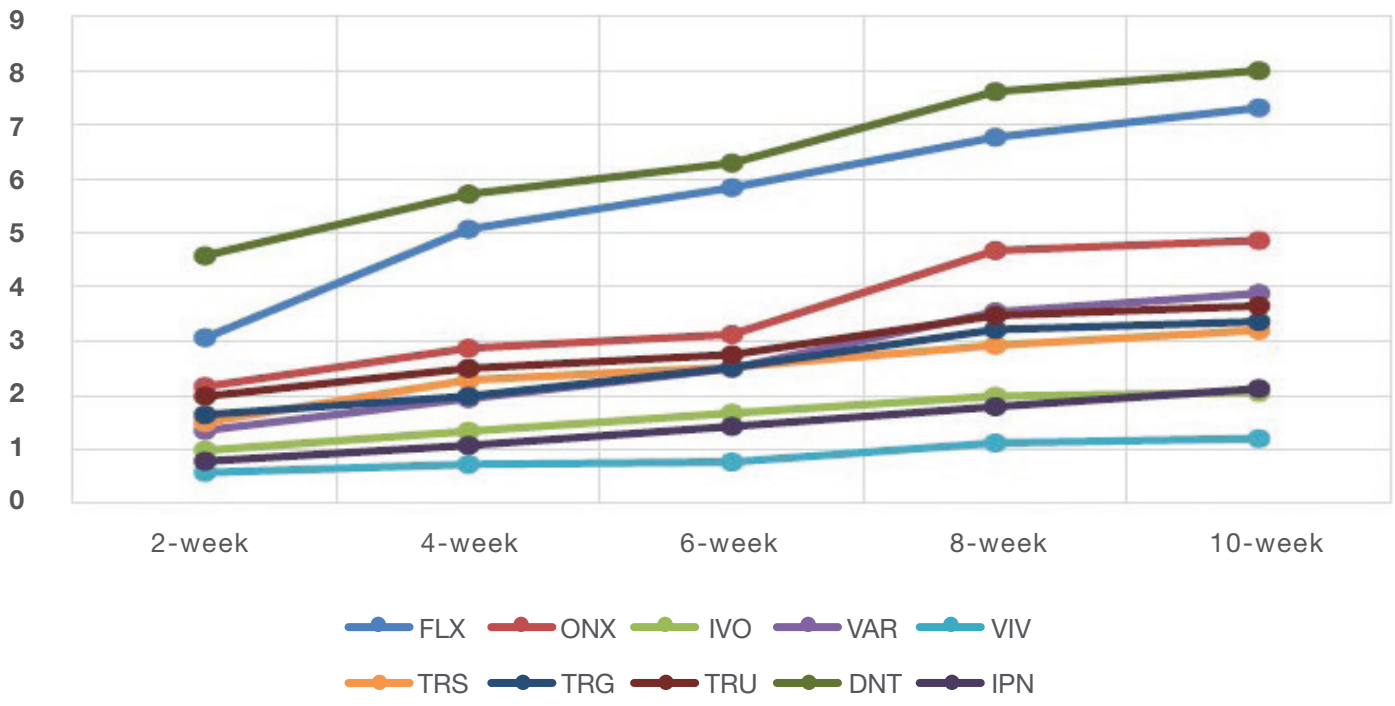
Figs. 1A&B. **WATER.** Mean ΔE from baseline at time intervals.

delta E	2-week	4-week	6-week	8-week	10-week
FLX	1.6	2.45	2.8	3.11	3.24
ONX	1.86	2.01	2.17	2.39	2.42
IVO	0.81	1.15	1.34	1.62	1.64
VAR	0.82	1.46	1.71	1.84	1.89
VIV	0.42	0.57	0.7	1	1.03
TRS	0.73	1.03	1.45	1.59	1.67
TRG	1.21	1.69	1.86	1.95	2.01
TRU	0.94	1.21	1.39	1.53	2.04
DNT	3.32	3.69	4.03	4.24	4.39
IPN	0.18	0.36	0.61	0.85	1.06



Figs. 2A&B. COFFEE. Mean ΔE from baseline at time intervals

delta E	2-week	4-week	6-week	8-week	10-week
FLX	3.06	5.07	5.84	6.77	7.31
ONX	2.16	2.87	3.12	4.67	4.86
IVO	0.98	1.33	1.67	1.98	2.05
VAR	1.35	1.94	2.5	3.54	3.88
VIV	0.57	0.72	0.77	1.12	1.2
TRS	1.5	2.28	2.52	2.92	3.2
TRG	1.64	1.98	2.51	3.21	3.36
TRU	1.98	2.5	2.75	3.47	3.65
DNT	4.58	5.72	6.29	7.61	8
IPN	0.78	1.07	1.42	1.79	2.12



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IVO	0.98	1.33	1.67	1.98	2.05
VAR	1.35	1.94	2.5	3.54	3.88
VIV	0.57	0.72	0.77	1.12	1.2
TRS	1.5	2.28	2.52	2.92	3.2
TRG	1.64	1.98	2.51	3.21	3.36
TRU	1.98	2.5	2.75	3.47	3.65
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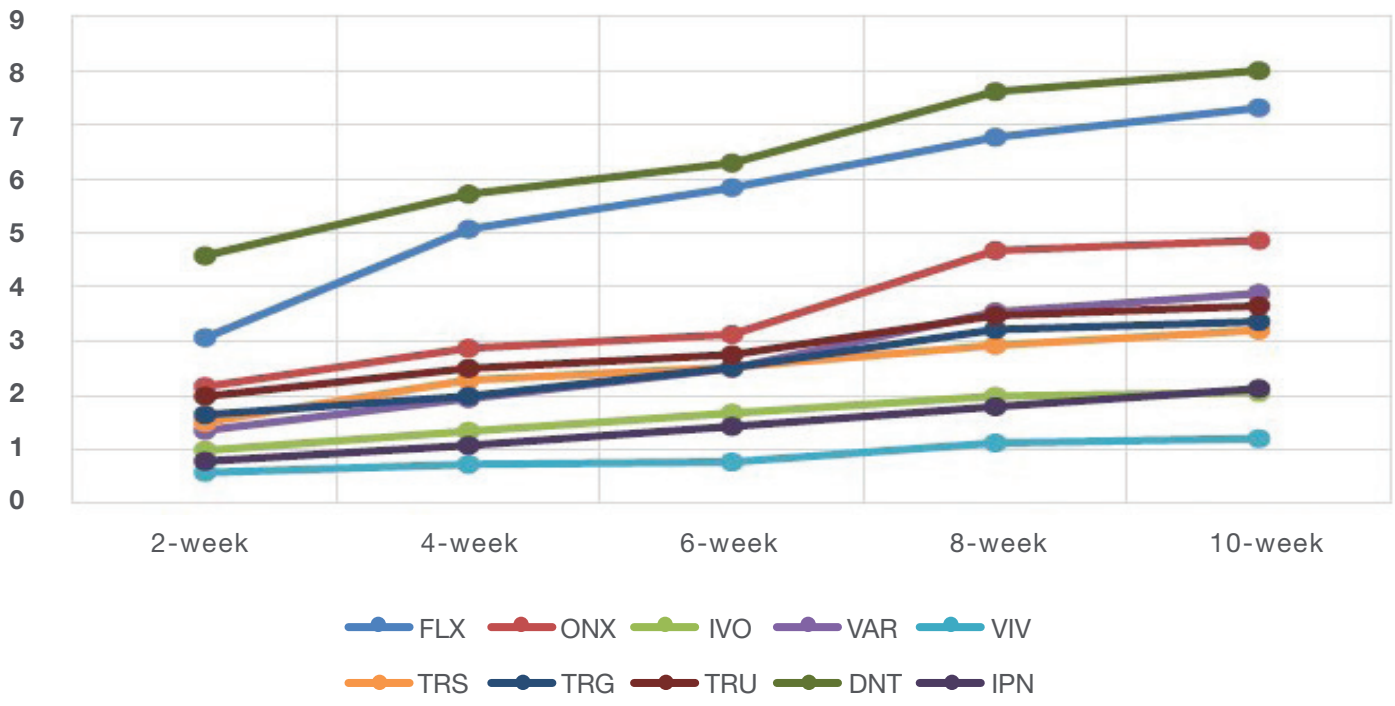
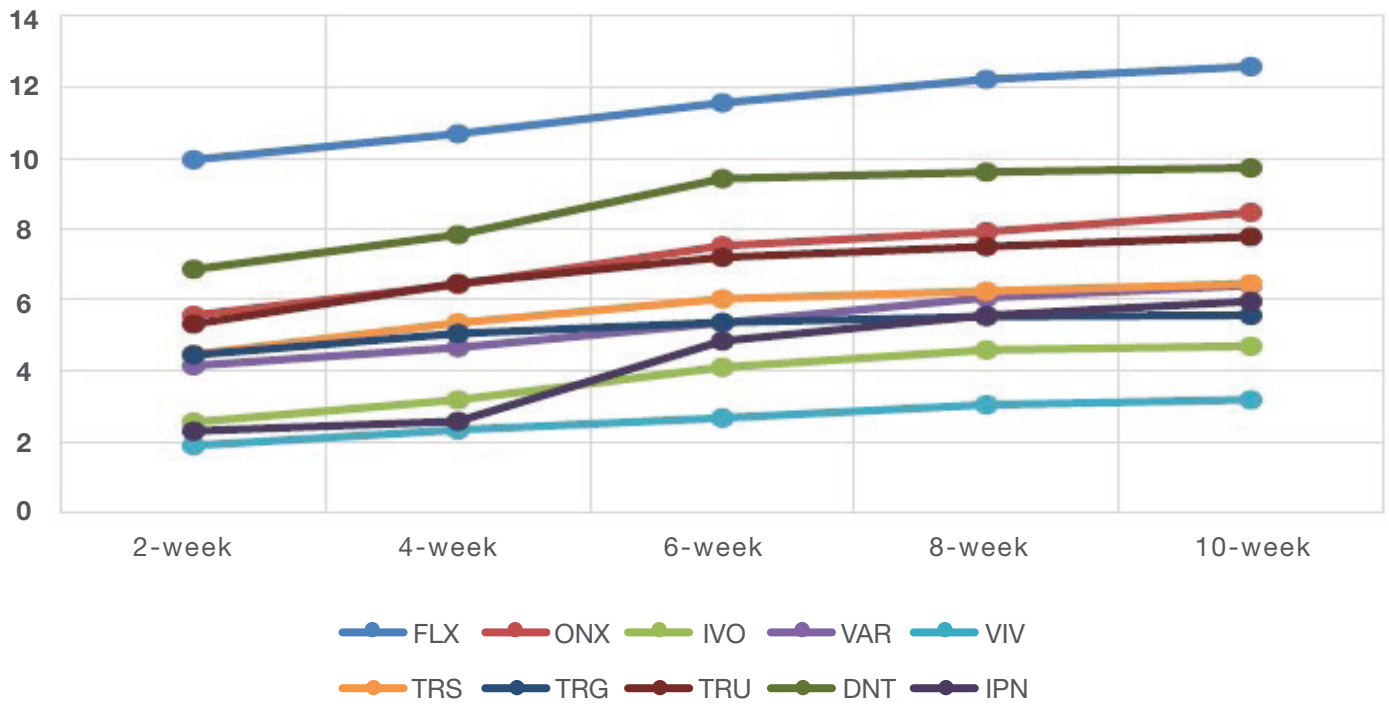


Figs. 3A&B. WINE. Mean ΔE from baseline at time intervals.

delta E	2-week	4-week	6-week	8-week	10-week
FLX	9.95	10.68	11.55	12.21	12.57
ONX	5.57	6.44	7.53	7.92	8.46
IVO	2.56	3.19	4.1	4.59	4.7
VAR	4.15	4.66	5.36	6.06	6.41
VIV	1.9	2.34	2.68	3.05	3.19
TRS	4.47	5.36	6.03	6.25	6.46
TRG	4.45	5.05	5.37	5.53	5.57
TRU	5.32	6.47	7.2	7.5	7.78
DNT	6.86	7.84	9.41	9.6	9.72
IPN	2.31	2.59	4.85	5.57	5.96



Conclusion

The color changes measured for the subtractive PMMA materials were lower than those of additive and conventionally processed polymer materials. The additive materials TrueDent, TrueDent Glossy, OnX, Trusana, Varseo Smile Crown Plus were similar in mean ΔE compared to the control denture tooth.

A totally unexpected discovery was that the TrueDent glossy printed surface was not different in color change from the highly polished TrueDent polymer.

Clinical Implications

Color stability is a vital aspect of dental prostheses because discoloration and darkening of teeth can lead to patient dissatisfaction or even denture rejection, necessitating a replacement.

The milled PMMA tooth polymers exhibited better color stability than the control denture tooth. Meanwhile, the 3D printed denture tooth polymers and one permanent crown polymer displayed similar color stability to the control denture tooth. Therefore, these materials are suitable alternatives for fabricating denture teeth, provisional prostheses, and definitive crowns, particularly concerning color stability.

To explore how TrueDent can elevate your dental lab's capabilities, reach out to one of our experienced dental specialists today.

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