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Investigation of the Shrinkage Behaviour, Surface Quality and Mechanical Properties of Beautifil II LS in Comparison with Com- mercially Available Composites

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Test report for Shofu Dental GmbH

10 pages, incl. 6 tables and 5 illustrations

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1. Objective

The objective of this investigation was to test Beautifil II LS in comparison with seven commercially available composite restoratives for shrinkage behaviour, surface quality and mechanical properties, such as flexural strength and modulus of elasticity.

2. Materials, Methods and Test Conditions

2.1 Materials

The composite materials tested are listed in Table 1, along with their codes and batch numbers.

Table 1: Products tested

Composite	Manufacturer	Code	Batch No.
Tetric Evo-Ceram	Ivoclar Vivadent	TE	U56297
Filtek Supreme XTE Universal	3M ESPE	FS	N784286
Venus Diamond	Heraeus Kulzer	VD	010062A
Ceram X	DENTSPLY De Trey	CX	1608000359
G-aenial	GC	GA	1605101
Herculite XRV	Kerr	HX	5920364
Admira Fusion	Voco	AF	1630296
Beautifil II LS	Shofu	BF	1605101

2.2 Methods and Test Conditions

Flexural Strength

Three-point flexural test to ISO 4049;

Specimen size: 2 mm × 2 mm × 25 mm

Specimen preparation: Light-curing on both sides for 180 s each in a Dentacolor XS unit (Heraeus Kulzer)

Storage: 24 hours in distilled water at 37°C

25,000 thermocycles between 5 and 55°C

Testing: Z005 universal testing machine (Zwick) at 23°C, dry

Crosshead speed: 1 mm·min⁻¹

Modulus of Elasticity

Calculated from the linear part of the stress-strain diagram obtained in the three-point flexural test.

Deflection

Calculated from the stress-strain diagram obtained in the three-point flexural test.

Dimensional Behaviour

Specimen size: Diameter = 5 mm, height = 2.5 mm

Specimen preparation: Placing a metal ring 5 mm in diameter and 2.5 mm in height on a quartz plate 2 mm in thickness and filling the ring with the composite material

Testing: Positioning a sensor, light-curing the composite for 20 s from below with a Bluephase curing light, determining the linear polymerisation shrinkage for a period of 2 min from start of curing with a DMA 7 (Perkin Elmer), based on the time-dependent change in height occurring during polymerisation.

Surface Quality

For *surface treatment*, specimens 20 mm in length, 5 mm in width and 2 mm in height were prepared and light-cured on both sides for 180 s each in a Dentacolor XS unit. The specimens were covered with plastic films during polymerisation to achieve smooth and homogeneous surfaces.

The surfaces that had been covered with films were polished with Super-Snap disks in the following order: 1. Black (Coarse), 2. Violet (Medium), 3. Green (Fine), 4. Red (Superfine).

Two specimens each were polished, and all specimens were included in the analysis. All specimens were polished at low pressures; then the abrasion dust was removed using compressed air. The specimens were polished until their surfaces were subjectively considered to be smooth. The time necessary to achieve this quality varied; generally about 1 min was needed.

The surfaces created by this treatment were scanned using a Hommel Tester T1000 surface profilometer, i.e. a mechanoelectric scanning system. The surface quality achieved was determined with the aid of parameters obtained from the surface profile

measurement. In this report, only the surface roughness parameter R_a is described, i.e. the arithmetic mean value of the departures of the profile from the mean line.

3. Results

3.1 Flexural Strength

Table 2 shows the flexural strength determined after storage for 1 day and after 25,000 thermocycles (TC). Fig. 1 represents the results graphically.

Table 2: Flexural strength of the composite restoratives tested after storage for 1 day and after 25,000 TC

Composite	Flexural Strength [MPa] Storage for 1 day	sd	Flexural Strength [MPa] 25,000 TC	sd
Tetric Evo-Ceram	110	11.8	86	11.0
Filtek Supreme XTE Universal	142	11.1	81	6.9
Venus Diamond	190	14.2	148	18.3
Ceram X	128	11.4	90	11.9
G-aenial	104	8.1	72	10.7
Herculite XRV	122	11.4	97	11.8
Admira Fusion	92	11.0	57	7.0
Beautiful II LS	120	7.3	80	7.8

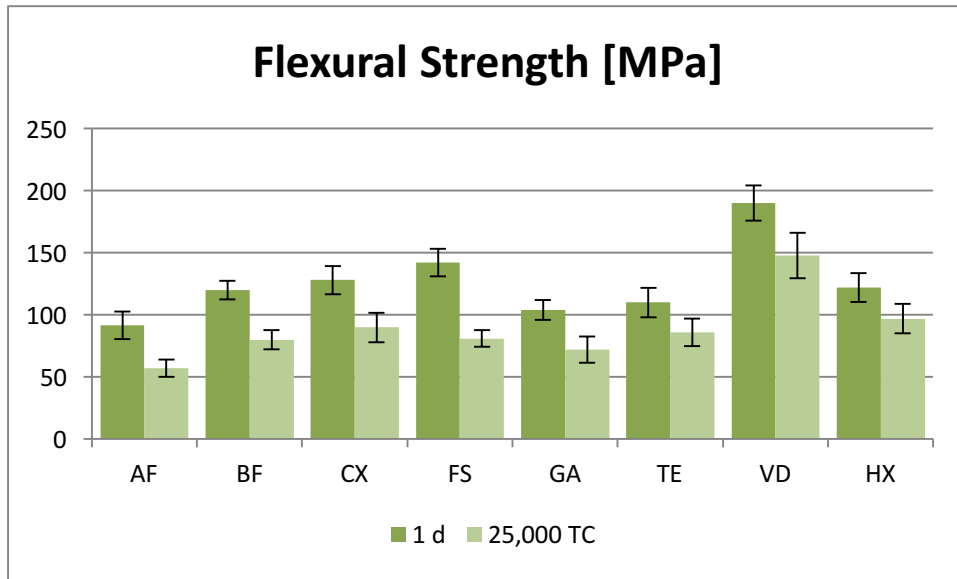


Fig. 1: Flexural strength of the composite restoratives tested after 1 day and after 25,000 TC

3.2 Modulus of Elasticity

Table 3 shows the modulus of elasticity determined after storage for 1 day and after 25,000 TC. Fig. 2 represents the results graphically.

Table 3: Modulus of elasticity of the composite restoratives tested after storage for 1 day and after 25,000 TC

Composite	Modulus of Elasticity [MPa] Storage for 1 day	sd	Modulus of Elasticity [MPa] 25,000 TC	sd
Tetric Evo-Ceram	8511	639	7910	545
Filtek Supreme XTE Universal	10278	915	9377	585
Venus Diamond	13111	995	12015	761
Ceram X	8573	745	7797	377
G-aenial	6089	329	6061	460
Herculite XRV	10980	579	10239	582
Admira Fusion	7702	802	5794	448
Beautifil II LS	7996	432	7422	583

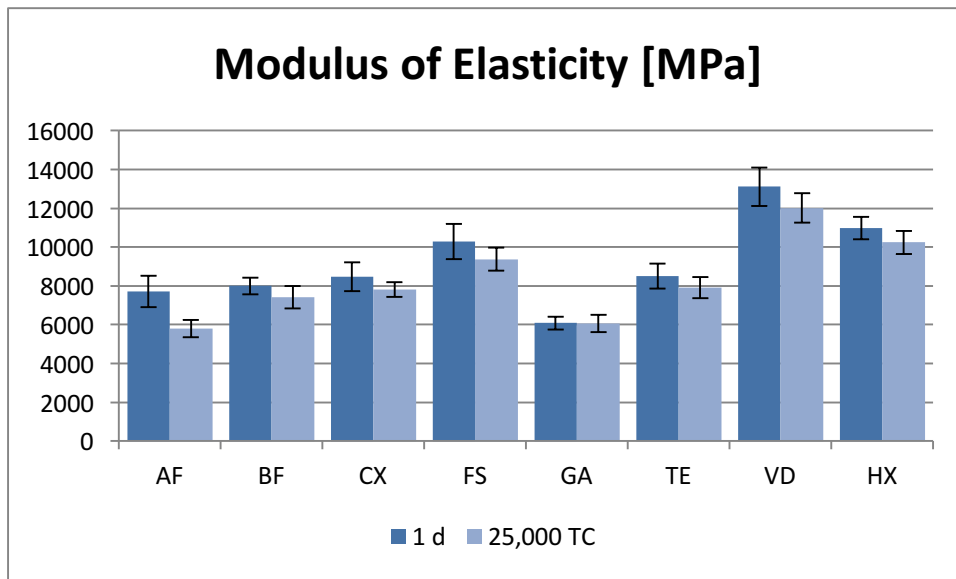


Fig. 2: Modulus of elasticity of the composite restoratives tested after 1 day and after 25,000 TC

3.3 Deflection

Table 4 shows the deflection (in %) determined after storage for 1 day and after 25,000 TC. Fig. 3 represents the results graphically.

Table 4: Deflection [%] of the composite restoratives tested after storage for 1 day and after 25,000 TC

Composite	Deflection [%] Storage for 1 day	sd	Deflection [%] 25,000 TC	sd
Tetric Evo-Ceram	1.2	0.2	1.0	0.1
Filtek Supreme XTE Universal	1.4	0.1	0.8	0.1
Venus Diamond	1.5	0.1	1.2	0.2
Ceram X	1.6	0.2	1.1	0.1
G-aenial	1.7	0.2	1.1	0.2
Herculite XRV	1.1	0.1	0.9	0.1
Admira Fusion	1.1	0.2	0.9	0.2
Beautifil II LS	1.5	0.1	1.0	0.1

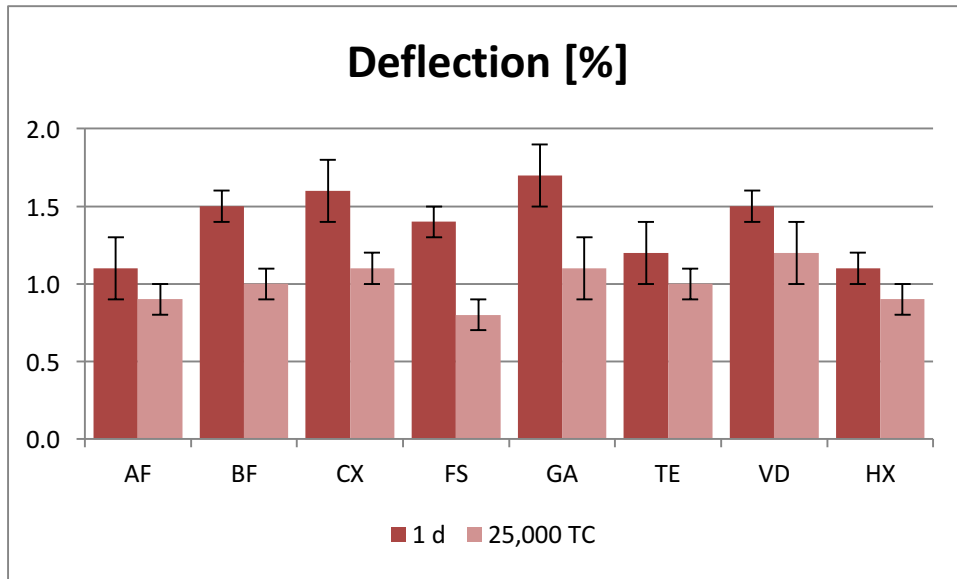


Fig. 3: Deflection of the composite restoratives tested after 1 day and after 25,000 TC

3.4 Dimensional Behaviour

Table 5 shows the linear polymerisation shrinkage (in %). Fig. 4 represents the results graphically.

Table 5: Linear polymerisation shrinkage of the composite restoratives tested

Composite	Polymerisation Shrinkage [% lin.]	sd
Tetric Evo-Ceram	1.09	0.11
Filtek Supreme XTE Universal	0.80	0.07
Venus Diamond	1.06	0.13
Ceram X	1.19	0.10
G-aenial	1.36	0.07
Herculite XRV	1.63	0.11
Admira Fusion	0.89	0.06
Beautiful II LS	0.80	0.03

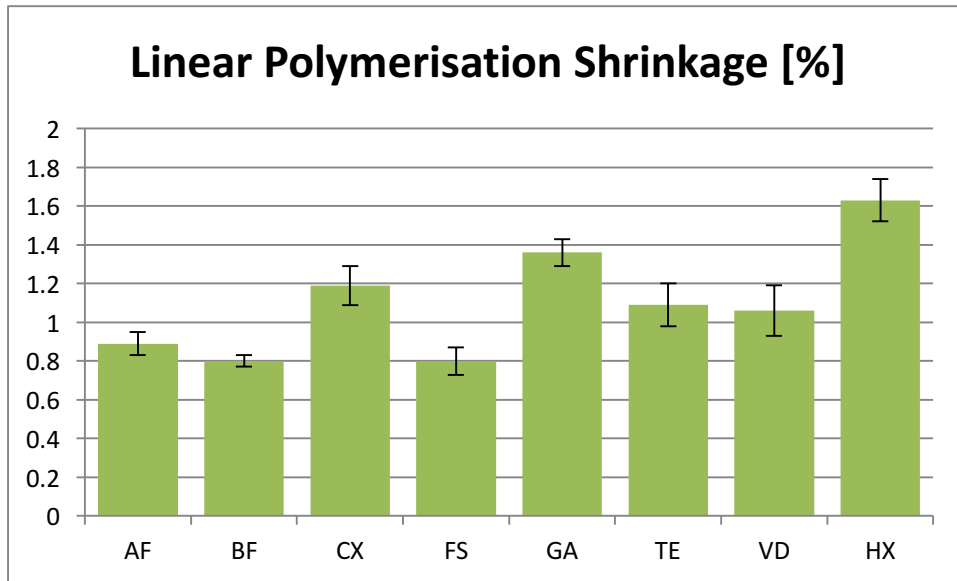


Fig. 4: Polymerisation shrinkage of the composite restoratives tested

3.5 Surface Quality

Table 6 shows the surface quality after polishing with Super Snap. Fig. 5 represents the results graphically.

Table 6: Mean arithmetic roughness (R_a) of the composite restoratives tested

Composite	R_a Value [μm]	sd
Tetric Evo-Ceram	0.048	0.007
Filtek Supreme XTE Universal	0.039	0.007
Venus Diamond	0.088	0.01
Ceram X	0.045	0.008
G-aenial	0.057	0.009
Herculite XRV	0.070	0.009
Admira Fusion	0.066	0.009
Beautifil II LS	0.045	0.005

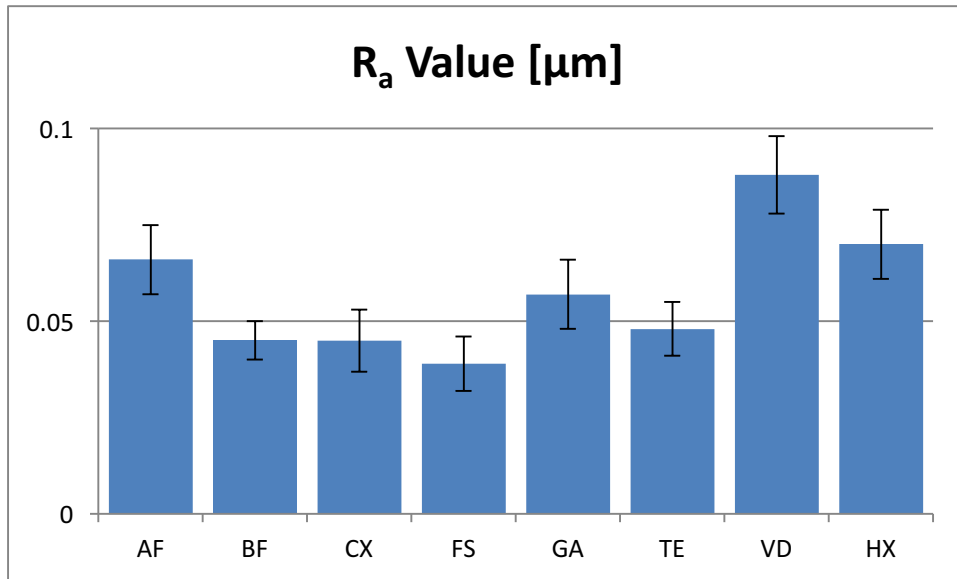


Fig. 5: Surface roughness of the composite restoratives tested after polishing with Super Snap

4. Summary

The investigation of Beautifil II LS in comparison with seven other composite restoratives yielded the following results:

Flexural Strength

The flexural strengths of the composites tested ranged from 90 to 190 MPa after 1 day. After 25,000 thermocycles (TC), the values of all products decreased by 57 to 78 %. Beautifil II LS showed an average decrease by 67 % after TC.

Modulus of Elasticity

The moduli of elasticity of the materials tested also varied greatly, ranging from 5,800 to 12,000 MPa. Beautifil II LS was relatively elastic, with a low value of 7,400 MPa. After 25,000 TC, the E-moduli of almost all products decreased only slightly.

Deflection

The deflection values ranged from 1.1 to 1.7 %. After 25,000 TC, all products showed a decrease in deflection, i.e. an increase in brittleness. Beautifil II LS showed a relatively high deflection value of 1.5 %.

Polymerisation Shrinkage

The linear polymerisation shrinkage values of the eight products tested ranged from 0.8 to 1.63 %. Beautifil II LS and Filtek Supreme XTE Universal showed the lowest polymerisation shrinkage.

Surface Quality after Polishing

All materials tested showed R_a values $< 0.1 \mu\text{m}$ after polishing with Super Snap. Filtek Supreme XTE Universal achieved the lowest surface roughness, i.e. the smoothest surfaces. Beautifil II LS and Ceram X followed in second place with a very low surface roughness of $0.045 \mu\text{m}$.