LABORATORY RESEARCH REPORT

Mechanical Behavior of a Premise

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Report Prepared For
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OBJECTIVE

The objective of this study was to characterize basic physical and mechanical properties of a new advanced hybrid composite dental restorative material [Premise (Kerr Dental Products)], and compare its behavior with 4 commercially available composite control materials [Filtek Supreme (3M-ESPE); Esthet·X (Dentsply Caulk); 4 Seasons (Ivoclar/Vivadent); TPH (Dentsply Caulk)].

PROTOCOL

MATERIALS AND METHODS:

Materials:

Five dental composite materials were evaluated. All materials were obtained commercially and then supplied by Kerr Dental Products to the investigator for this study.

TABLE 1: List of Proposed Materials (5)

(1) PREMISE™	**Kerr**	**Advanced Hybrid Composite Material**
(2) Filtek™ Supreme	3M-ESPE	Nano-hybrid Composite Material
(3) Esthet·X®	Dentsply Caulk	Micro-hybrid Composite Material
(4) 4 Seasons®	Ivoclar/Vivadent	Micro-hybrid Composite Material
(5) TPH™	Dentsply Caulk	Hybrid Composite Material

Materials Manipulation:

All materials will be manipulated following the stated instructions in individual manufacturers' enclosures in the package. All instructions will be recorded in detail for reported results.

Specimen Preparation for Mechanical Testing:

All specimens were prepared by dispersing material into appropriate molds for specific mechanical tests. The number of specimens is reported in the test descriptions below. Specimens were light-cured (Demetron 501curing light) for 40 s (or for the manufacturer's recommended curing time) on each side (when applicable), aged for 1 week in deionized and distilled water (37°C), and polished (when appropriate) through 1200 grit SiC abrasive.

Mechanical Testing:

All samples were tested wet at 25°C. Tests were conducted on a model 4411 Instron universal testing machine operating typically at 0.5 mm per minute CHS. Test information was recorded using computer software (Testworks Version 4, MTS Corporation) allowing automatic interpretation of stress-strain curve points or areas.

TABLE 2: Mechanical Tests (Individual test procedures are referenced):
[All tests will be run at 25°C (in water when applicable)]

Compressive Strength:
Recommended number of specimens per material: 10
Total number of specimens for test: 50
Reference for Procedure: ISO Standard 9917 (International Standards Organization)

Diametral Tensile Strength:
Recommended number of specimens per material: 10
Total number of specimens for test: 50
Reference for Procedure: ISO Standard 9917 (International Standards Organization)

Flexural Strength (3 pt. Bend):
Recommended number of specimens per material: 10
Total number of specimens for test: 50
Reference for Procedure: ISO Standard 4049 (International Standards Organization)

Young's (flexural) Modulus:
Values will be obtained from stress-strain curves for 3-pt. flexural strength specimens.
Recommended number of specimens per material: 10
Total number of specimens for test: 50
Reference for Procedure: ISO Standard 4049 (International Standards Organization)

Hardness (Vickers):
Recommended number of measurements per material: 10
Total number of specimens per material for test: 3 (≥ 3 measurements per specimen)
Total number of specimens for test: 15
Reference for Procedure: Thompson and Anusavice, *J Dent Res*, 1994; 73: 505-510.

Polymerization Shrinkage:
Helium pycnometry will be used to evaluate polymerization shrinkage.
Recommended number of measurements per material: 10
Total number of specimens for test: 50
Reference for Procedure: Cook *et al*., *Dent Mater,* 1999; 15:447-449.

Statistical Analysis:

All groups of specimens for specific mechanical property tests were analyzed for means and standard deviations. Groups were compared within tests using ANOVA and post-hoc t-tests ($p \leq 0.05$).

RESULTS

Summary Tables of Physical Property Tests:

Table 3: Flexural Modulus (E_f, GPa) –

PREMISE™	Esthet·X®	Filtek™ Supreme	4 Seasons®	TPH™
6.7 ± 0.4^b	7.3 ± 0.3^b	6.8 ± 0.3^b	7.2 ± 0.6^b	8.2 ± 0.5^a

*Superscript letters (a, b) represent statistically equivalent means for each cyclic interval.

Table 4: Compressive Modulus (E_c, GPa) –

PREMISE™	Esthet·X®	Filtek™ Supreme	4 Seasons®	TPH™
3.2 ± 0.4^c	4.3 ± 0.8^b	3.4 ± 0.6^c	4.1 ± 0.5^b	5.1 ± 0.2^a

*Superscript letters (a, b, c) represent statistically equivalent means for each cyclic interval.

Table 5: Polymerization Shrinkage (vol %) –

PREMISE™	Esthet·X®	Filtek™ Supreme	4 Seasons®	TPH™
0.8 ± 0.4^a	1.7 ± 0.3^b	2.2 ± 0.8^b	1.8 ± 0.5^b	2.5 ± 0.4^b

*Superscript letters (a, b) represent statistically equivalent means for each cyclic interval.

Statistical Analysis for Physical Property Tests:

For flexural modulus, Premise had the lowest measured mean value, although statistically its mean flexural modulus was equivalent to the mean values for EsthetX, Filtek Supreme, and 4 Seasons. TPH had a significantly higher mean flexural modulus than each of the other composites tested. For compressive modulus, Premise had the lowest measured mean value, which was significantly lower than each of the other composite materials tested. TPH had a significantly higher mean compressive modulus than each of the other composites tested. For volumetric polymerization (curing) shrinkage, Premise had the lowest measured mean value (*mean volumetric shrinkage was 50% that of the next best measured value*). There was no statistical difference in the measured volumetric (curing) shrinkage of the other four composite materials tested. The statistical sub-groupings for each test are identified in the tables by superscript letters.

Summary Tables of Mechanical Property Tests:

Table 6: Compressive Strength (σ_c, MPa) –

PREMISE™	Esthet·X®	Filtek™ Supreme	4 Seasons®	TPH™
210.6 ± 59.5[a]	247.9 ± 28.9[a]	220.1 ± 48.4[a]	189.8 ± 38.7[a]	224.0 ± 41.0[a]

*Superscript letters (a) represent statistically equivalent means for each cyclic interval.

Table 7: Diametral Tensile Strength (σ_{dt}, MPa) –

PREMISE™	Esthet·X®	Filtek™ Supreme	4 Seasons®	TPH™
32.7 ± 4.5[bc]	37.7 ± 4.3[b]	30.2 ± 5.8[c]	27.9 ± 6.8[c]	47.3 ± 5.6[a]

*Superscript letters (a, b, c) represent statistically equivalent means for each cyclic interval.

Table 8: Flexural Strength (3-point flexure, σ_f, MPa)–

PREMISE™	Esthet·X®	Filtek™ Supreme	4 Seasons®	TPH™
93.3 ± 12.4[bc]	103.8 ± 8.5[b]	81.8 ± 13.1[c]	85.3 ± 4.4[c]	127.1 ± 22.4[a]

*Superscript letters (a, b, c) represent statistically equivalent means for each cyclic interval.

Table 9: Diamond Pyramid Hardness (Vickers, VHN, kg/mm^2) –

PREMISE™	Esthet·X®	Filtek™ Supreme	4 Seasons®	TPH™
57.8 ± 1.6[d]	66.4 ± 2.3[c]	85.1 ± 3.7[a]	71.1 ± 3.2[c]	78.9 ± 6.6[b]

*Superscript letters (a, b, c, d) represent statistically equivalent means for each cyclic interval.

Statistical analysis for Mechanical Property Tests:

For compressive strength, there was no statistically significant difference between any of the measured mean values. The mean compressive strength value for Premise fell squarely in the middle for the five composite materials tested. For diametral tensile strength (DTS), the measured mean value for Premise was statistically equal to each of the other composite materials tested except for TPH. The measured mean DTS value for TPH was significantly higher than each of the other composite materials tested. For flexural strength, the measured mean value for Premise was statistically equal to each of the other composite materials tested except for TPH (which had a mean flexural strength significantly higher than each of the other composites tested). The mean flexural strength value for Premise feel directly in the middle of the five materials tested, and was approximately 15% higher then the mean value for Filtek Supreme and approximately 10% higher than the mean value for 4 Seasons (although each of these means was not statistically different). For microhardness, the mean Vickers hardness number (VHN) for Premise was significantly lower than the mean VHN of each of the other composite materials tested. Filtek Supreme had the highest measured VHN of the five composite materials. The statistical sub-groupings for each test are identified in the tables by superscript letters.

Summary

Clearly the most noticeable differences between Premise and the other composite materials tested are the shrinkage and hardness results. Premise displayed significantly lower volumetric curing shrinkage then each of the other materials tested. Additional specimens of Premise were actually tested to confirm the low values that were measured. Although a helium pycnometry technique might not give 100% accurate values in a quantitative sense (and a strong argument could be made that every method that has been reported for measuring the shrinkage of light-cured dental composite materials has some inherent problems), qualitatively it is clear that Premise shrinks less than the other materials tested in this study. In regard to the hardness testing results, Premise clearly has a lower microhardness than the other materials in this study. This will likely lead to very good polishability, and perhaps higher wear rates, although there is not a strict correlation between microhardness and wear. Wear is a complex process that is related to a variety of material and environmental characteristics (yield strength, fracture toughness and initial surface morphology of the material; hardness and morphology of the antagonist; nature of the fluid or gaseous environment, etc.), and really must be evaluated independently (in an appropriately designed wear test for the intended application). Microhardness is also related to the microstructure of the material being tested (although large enough indentation loads were used in this evaluation to ensure sampling of the entire microstructure). Because of the microhardness results, it might be worthwhile to explore conducting some long-term wear simulations (3-body wear or toothbrush abrasion tests out to an equivalence of at least three years). For each of the other physical and mechanical properties evaluated, Premise performed in a manner very similar to that of the other composite materials tested. TPH displayed marginally better fracture strength values than the other materials, but it is structurally in a slightly different classification than the other composites.