

LABORATORY RESEARCH REPORT

Evaluation of Herculite Ultra

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SPONSOR

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A handwritten signature in blue ink that reads "Jeffrey Y. Thompson". The signature is written in a cursive style with a long horizontal stroke at the end.

Jeffrey Y. Thompson, PhD
Davie, FL

PROTOCOL

MATERIALS AND METHODS:

Materials:

All materials were supplied by Kerr Corporation to the investigator for this investigation.

TABLE 1: List of Composites For Study (6)*

**All composites A3 shade*

(1) Herculite Ultra	Kerr
(2) Gradio Direct	GC America
(3) Tetric EvoCeram	Ivoclar
(4) TPH3	Dentsply
(5) Filtek Supreme Plus	3M-ESPE
(6) Esthet-X HD	Dentsply

Materials Manipulation:

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

Specimen Preparation for Testing:

All specimens were prepared by dispersing material into appropriate molds for specific tests. The number of specimens is reported in the test descriptions below. Specimens for mechanical testing were cured and then aged for accordingly in deionized/distilled water (37°C) prior to testing, except for initial gloss measurements (t = 0, just after curing). A Mylar strip was placed on the surface of composite between the composite surface and the light tip to decrease the probability of oxygen inhibition.

Mechanical Testing:

All samples were tested in ambient conditions.

TABLE 3: Mechanical Tests (Individual test procedures are referenced):

[All tests were run at 25°C (in water when applicable)]

Radiopacity:

Number of specimens per group: 4 (3 measurements per specimen)

Total number of specimens for test: 24

Total number of measurements for test: 72

Reference for Procedure: ISO Standard 4049 (International Standards Organization)

Gloss (after grinding):

Number of specimens per group: 5 (3 measurements per specimen at t=0 and after grinding)

Total number of specimens for test: 30

Total number of measurements for test: 180

Reference for Procedure: Kakaboura *et al.*, J Mater Sci: Mater Med (2007) 18:155-163.

Gloss (after toothbrush abrasion):

Number of specimens per group: 5 (3 measurements per specimen at t=0 and after TB abrasion)

Total number of specimens for test: 30

Total number of measurements for test: 180

Reference for Procedure: Kakaboura *et al.*, J Mater Sci: Mater Med (2007) 18:155-163.

Three point flexure and flexural modulus:

Number of specimens per group: 12

Total number of specimens for test: 72

Reference for Procedure: ISO Standard 4049 (International Standards Organization)

Fracture Toughness (Single Edge Notched Beam):

Number of specimens per group: 12

Total number of specimens for test: 72

Reference for Procedure: ASTM Standard E399-74 (American Society for Testing Materials)

Statistical Analysis:

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

RESULTS

Summary table of test results:

Radiopacity

Material	Radiopacity Equivalent mm of Al (mm ± sd)	Radiopacity % Equivalent to 1.0 mm of Al (%)
Herculite Ultra <i>Kerr</i>	2.5 ± 0.2 ^b	250 ± 20 ^b
Gradio Direct <i>GC</i>	0.5 ± 0.2 ^c	50 ± 20 ^c
Tetric EvoCeram <i>Ivoclar</i>	3.0 ± 0.2 ^a	300 ± 20 ^a
TPH3 <i>Dentsply</i>	2.4 ± 0.2 ^b	240 ± 20 ^b
Filtek Supreme Plus <i>3M-ESPE</i>	2.2 ± 0.2 ^b	220 ± 20 ^b
Esthet-X HD <i>Dentsply</i>	2.9 ± 0.2 ^a	280 ± 20 ^a

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

Fracture Toughness

Material	Fracture Toughness (MPa·m ^{1/2} ± sd)
Herculite Ultra <i>Kerr</i>	1.49 ± 0.21 ^{ab}
Gradio Direct <i>GC</i>	1.29 ± 0.27 ^{bc}
Tetric EvoCeram <i>Ivoclar</i>	1.33 ± 0.28 ^{bc}
TPH3 <i>Dentsply</i>	1.65 ± 0.26 ^a
Filtek Supreme Plus <i>3M-ESPE</i>	1.12 ± 0.23 ^c
Esthet-X HD <i>Dentsply</i>	1.63 ± 0.20 ^a

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

Gloss
(Abraded – 240 grit SiC, 1 min; 600 grit SiC, 1 min)

Material	Gloss 60° (as cured; t = 0)	Gloss 60° (after grinding)
Herculite Ultra <i>Kerr</i>	85.7 ± 2.1 ^b	11.1 ± 1.5 ^a
Gradio Direct <i>GC</i>	76.8 ± 2.2 ^c	6.0 ± 0.9 ^b
Tetric EvoCeram <i>Ivoclar</i>	87.5 ± 2.0 ^b	11.1 ± 2.4 ^a
TPH3 <i>Dentsply</i>	88.1 ± 2.1 ^{ab}	3.8 ± 1.1 ^c
Filtek Supreme Plus <i>3M-ESPE</i>	91.9 ± 1.2 ^a	12.8 ± 2.6 ^a
Esthet-X HD <i>Dentsply</i>	84.5 ± 2.3 ^b	5.8 ± 1.1 ^b

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

Gloss
(Toothbrush abraded -10,000 cycles, 350g pressure, 90 strokes per min)

Material	Gloss 60° (as cured; t = 0)	Gloss 60° (after brushing)
Herculite Ultra <i>Kerr</i>	90.4 ± 2.0 ^a	34.5 ± 2.0 ^a
Gradio Direct <i>GC</i>	77.2 ± 2.1 ^c	8.9 ± 1.5 ^d
Tetric EvoCeram <i>Ivoclar</i>	86.1 ± 2.3 ^b	11.5 ± 2.1 ^c
TPH3 <i>Dentsply</i>	87.6 ± 1.6 ^b	7.7 ± 2.0 ^d
Filtek Supreme Plus <i>3M-ESPE</i>	90.8 ± 1.7 ^a	16.7 ± 2.4 ^b
Esthet-X HD <i>Dentsply</i>	85.5 ± 2.3 ^b	10.5 ± 1.9 ^c

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

Flexural Strength

Material	3-pt. Flexure Strength (MPa ± sd)
Herculite Ultra <i>Kerr</i>	160.1 ± 10.1 ^b
Gradio Direct <i>GC</i>	140.3 ± 10.2 ^c
Tetric EvoCeram <i>Ivoclar</i>	188.6 ± 17.7 ^a
TPH3 <i>Dentsply</i>	154.7 ± 12.3 ^{bc}
Filtek Supreme Plus <i>3M-ESPE</i>	154.8 ± 15.9 ^{bc}
Esthet-X HD <i>Dentsply</i>	161.4 ± 13.4 ^b

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

Flexural Modulus

Material	Flexural Modulus (GPa ± sd)
Herculite Ultra <i>Kerr</i>	7.9 ± 0.9 ^{bc}
Gradio Direct <i>GC</i>	5.5 ± 0.7 ^d
Tetric EvoCeram <i>Ivoclar</i>	12.1 ± 1.3 ^a
TPH3 <i>Dentsply</i>	8.5 ± 1.1 ^{bc}
Filtek Supreme Plus <i>3M-ESPE</i>	9.6 ± 1.2 ^b
Esthet-X HD <i>Dentsply</i>	7.7 ± 0.8 ^c

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

Summary:

Herculite Ultra displayed physical, mechanical, and optical properties similar to the other materials tested with a few exceptions. It performed exceptionally well in the Gloss evaluations, where it retained its finish significantly better than each of the other materials after toothbrush abrasion. It also did as well as any other material after grinding with abrasive papers (in regards to gloss retention). Herculite Ultra had measured mechanical and physical properties in line with what would be expected, and values for fracture toughness, flexure strength and flexural modulus were intermediate in regards to the matrix of materials tested. An odd behavior noted was the high radiolucency measured for Gradio Direct, which is surprising for a currently available commercial composite.