

Important Properties of Filtek One Bulk Fill Restorative

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Experimental Design:

Materials:

Composites: Filtek One Bulk Fill Restorative A2 Lot: N859186 (3M Restoratives)

Curing Light Units: Elipar Deep Cure-S (3M Oral Care), Celalux 3 (VOCO), Bluephase 16i in low power mode (Ivoclar Vivadent, Inc.)

Methods:

Depth-of-cure (DoC) and Vickers Hardness: Composite material was packed into a stainless steel split mold, 4.5 mm in diameter, and 9 mm in height, and covered by Mylar. The curing lights were placed contacting the top surface and concentric and the curing light turned on for exposure time according to manufacturer instructions. The height of the cylinder was measured and divided by 2 to give the DoC according to the ISO 4049 scrape method. The top surface was measured for Vickers microhardness using a *HMV G21-DT* hardness tester (Shimadzu) at a 200g (1.96 N) load and 10 second dwell time. One half of the split mold was removed and half of the cylinder removed by grinding with 320 grit SiC paper and finished with 600 and 800 (p2400) grit SiC abrasive paper (Buehler). The exposed portion of the material had the Vickers microhardness measured 3 times for each depth for each specimen, every 0.5 mm from the top surface (closest to light exposure) for 9 indents per depth for each test group. The depth of cure was calculated using Microsoft Excel from the 3rd power polynomial trend line at the depth that the hardness ratio reaches 80%. A graph depicting the change in hardness was made with the level marked at which the hardness ratio, $(H_n/H_{top}) * 100 = 80\%$ where H_n is the hardness at the measured depth, is deemed a clinically acceptable level of cure and used to give a depth of cure in mm. The irradiance of each light was measured using a *Bluephase 2 Meter* (Ivoclar Vivadent, Inc.) accurate to $\pm 10\%$. The mean depth of cure per curing parameter and graphs showing the microhardness ratio by depth and microhardness values are reported.

Radiopacity: Digital x-rays of 1 cm diameter X 1 \pm 0.03 mm thick discs of composite were taken along-side an aluminum step wedge using a *RVG 6200* sensor (Carestream Dental) and *Gendex GX-770* x-ray head under the anatomical setting. The images were analyzed in Photoshop using the histogram function to determine grey levels and measure and compare the radiopacity in units of mm of aluminum/mm of composite thickness. Means and standard deviation are reported.

Flexural and Compressive Strength: Flexural strength bars 2 mm x 2 mm x 25 mm were cured in a stainless steel mold covered by Mylar with 20s x3 overlapping light exposures on the top and bottom. The specimens were stored in 37 °C DI water for 24h before being finished through 800 grit SiC paper. They were tested using an Instron 5866 Universal tester in 3-pt bend with a 20 mm span and 1 mm/min crosshead speed. Flexural Modulus was calculated from the load-deflection curve using the Instron Bluehill 2 software. Compressive strength specimens were cured in a Teflon mold covered by Mylar to make 4 mm diameter, 8 mm high specimens and cured for 40 seconds on the top and bottom before being stored for 24 h in 37 °C DI water. They were tested using an Instron 5866 Universal tester in compression with a 1 mm/min crosshead speed.

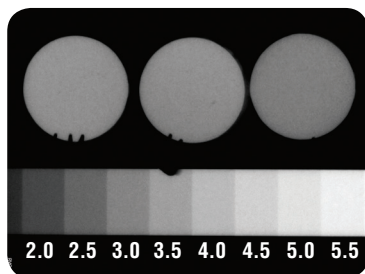


Fig. 1 Radiograph of 1 mm thick specimens next to an aluminum step wedge with 0.5 mm steps. The notch is at 3.5 mm of thickness.

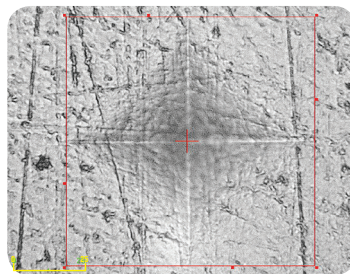


Fig. 2 Example of an indent under 400x magnification used for measurement.

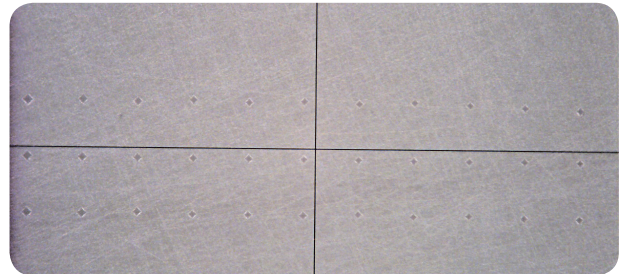


Fig. 3 Example of specimen after indents made every 0.5 mm.

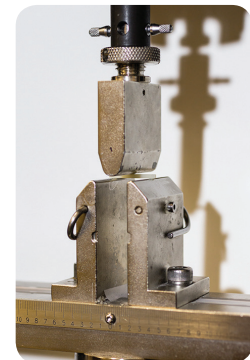
Results:

Filtek One Bulk Fill Results Summary			
Radiopacity, mm alum/mm composite	3.1 (0.1)		
Flexural Strength, MPa	183 (5)		
Flexural Modulus, GPa	10.6 (0.2)		
Compressive Strength, MPa	347 (24)		
Depth of Cure and Vickers Hardness			
Curing Light Unit	Elipar Deep Cure-S	Celalux 3	Bluephase 16i LP
Exposure Time, s	20	20	40
Irradiance, mW/cm²	1500	1000	600
Average Vickers Hardness of Top Surface, HV/0.2	55.2 (0.3)	52.0 (0.7)	53.2 (0.5)
Average Vickers Hardness at 4 mm, HV/0.2	45.0 (1.2)	43.4 (1.3)	46.3 (0.5)
DoC, 80% Hn/Htop	4.05	4.25	4.56
DoC Scrape Method, mm	4.0	4.0	4.1

Means with standard deviations in parentheses



HMV G21-DT hardness tester (Shimadzu)



3-point bend flexural strength with Instron 5866 Universal tester

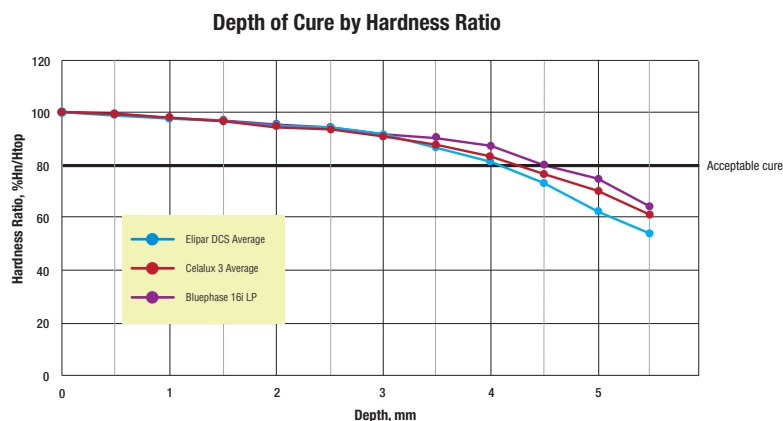


Fig. 4 The depth of cure is plotted according to the average hardness ratio Hn/Htop of *Filtek One Bulk Fill* after curing with each light. A line is drawn at the 80% ratio to indicate an acceptable cure.

Discussion:

There was an interesting result in which the higher powered *Elipar Deep Cure-S* (EDCS) light gave the highest hardness value at the surface but with a larger drop-off in hardness per depth. This may be due to a faster setting by the material on the top surfaces causing the characteristic increase in opacity for this material to attenuate more light. Despite the faster drop in hardness at depth from the top hardness, the *Elipar Deep Cure-S* still resulted in a greater hardness at a 4 mm depth than the *Celalux 3*.



Measuring compressive strength with Instron 5866 Universal tester

Conclusions:

Filtek One Bulk Fill has an excellent radiopacity of 310% equivalence to aluminum. The material successfully cured to the indicated 4 mm depth of cure according to 2 test methods and with 3 lights ranging in irradiance from 600-1500 mW/cm². *Filtek One Bulk Fill* recorded the highest flexural strength at 183 MPa of any direct composite tested in our lab and a high compressive strength of 347 MPa.

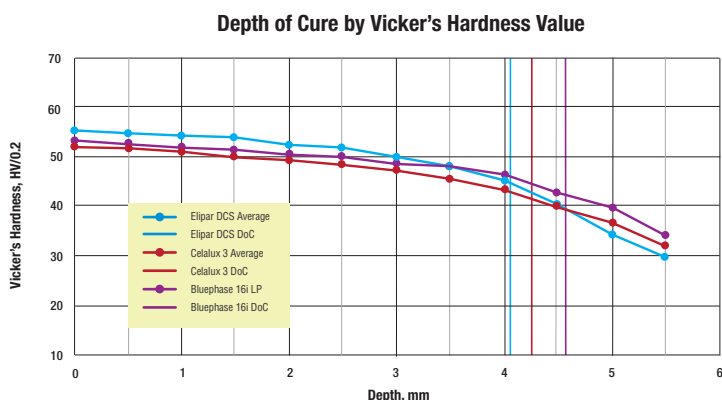


Fig. 5 The hardness values at each depth is plotted with vertical lines drawn showing the calculated depth of cure at which the Hn/Htop ratio = 80%.