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Biomaterials Research Report

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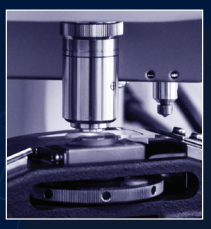


Number #120 – October, 2018

Comparison of Important Properties of Ecosite Bulk Fill and Competitive Materials

M. Cowen, J.M. Powers

Introduction:

Ecosite Bulk Fill

Bulk-filled composites are a relatively recent innovation to composite restoratives which allow a clinician to place composites in larger increments than was previously possible. This time savings came with a cost because early bulk filled materials were weaker and less esthetic than traditional composites as they used a lower inorganic filler load in order to increase light transmission. Recent innovations have sought to allow an even greater depth of cure while maintaining important properties such as polishability, strength and handling properties. This increased depth of cure also gives confidence that composites at the cavity walls will receive adequate light for all indications as partially uncured composites have the potential to allow uncured monomers to be released causing inflammation, have reduced mechanical properties and increased leakage. It is therefore advantageous for a bulk-filled composite to cure as well as possible, even in situations in which a curing light output may be lower than expected, a placed composite increment is thicker than estimated, or optimal placement of the curing light tip is difficult.

A common way that depth of cure is measured includes measuring the hardness of the cured composite as it has been shown that the hardness correlates to the monomer to polymer conversion. This method which we employed in this study allows us to directly measure the curing efficacy of the composites in a standardized way, and compare how different composites will cure with the same light energy applied.

We also evaluated how these different composites are able to be polished by measuring the glossiness and surface roughness at incrementally greater time spent polishing. This shows what the ultimate luster which can be achieved with each composite, and the relative time it takes to polish each composite. Having a great polish with as little time spent polishing is a goal every manufacturer should strive to achieve for these materials.

Experimental Design:

Materials:

Ecosite Bulk Fill (DMG America), ***Tetric EvoCeram Bulk Fill*** (Ivoclar Vivadent, Inc.)
Filtek One Bulk Fill (3M Oral Care), ***SonicFill 2*** (Kerr Restorative)

Methods:

Depth of Cure and Micro-Vickers Hardness n=3: Composite was cured for 20 seconds with an Elipar Deep Cure-S (3M Oral Care) in a stainless steel split mold, 4.5 mm in diameter and up to 12 mm in depth with the top surface covered by Mylar. The specimens were then immediately removed and opposing side ground flat through 800 grit ANSI SiC paper along the length. Vickers hardness measurements were made every 0.5 mm along the length to generate a curve to determine the depth at which 80% of the hardness is achieved compared to the hardness at the surface closest to the light, indicating an acceptable depth of cure. Mean Vickers hardness values of the top surface and standard deviations are also be reported. Depth of cure was also measured according to the scrape back ADA 27/ISO 4049 method in which half of the measured height will be indicated as the depth of cure for comparison on the same specimens as the Vickers hardness specimens.

Polishing and Specimen Preparation: The composites were cured in a mold (10 mm in diameter, 2-mm thick) with a Mylar strip according to manufacturers' instructions. The specimens were uniformly finished with 320 grit SiC paper to simulate a composite adjusted with a fine grit bur. The specimens were polished for 10, 20, 30, and 40 seconds (n=5 each) with ProGloss (Kerr Rotary) according to manufacturer's instructions while held in a flexible silicone mold. Specimens were also polished for an indefinite time (over two minutes) until no further measureable increase in gloss was achieved with the polishing system used.

Gloss: The gloss was measured over a 2 mm x 2 mm area using a small area glossmeter at 60° (Novo-Curve, Rhopoint Instruments), with 3 measurements taken every 120° of orientation per test group. Mean values and standard deviations of gloss were determined at each time point to generate a time dependent gloss curve.

Surface Roughness and 3D Topography: Surface roughness was measured using an atomic force microscope (Veeco Dimensional Icon) with 3 scans taken per surface per test group over an 80 x 80 µm surface area. Surface roughness was automatically calculated using NanoScope Analysis (Bruker) software with hundreds of measurements per scan. Mean surface roughness with standard deviations are reported. A curve was generated to show surface roughness and gloss over time and representative 3D images of surface topography compared.

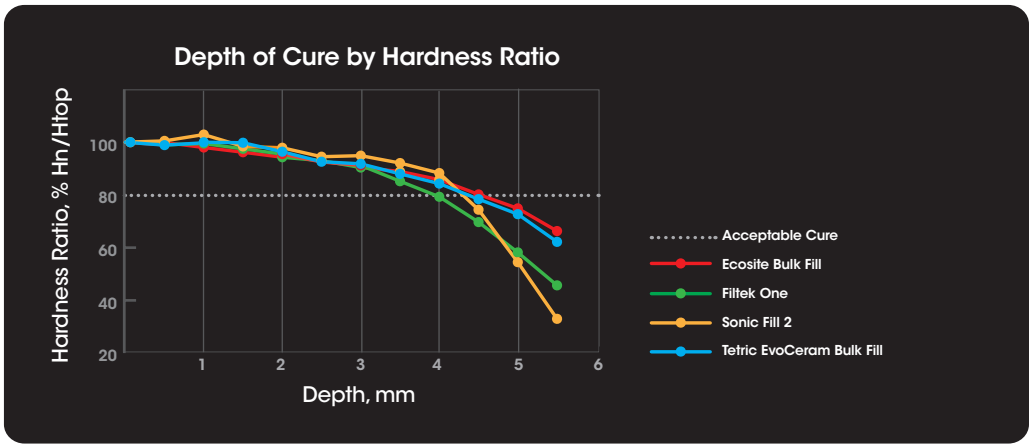
Conclusions:

EcoSite Bulk Fill exhibited excellent polishability compared to the competitive materials tested, with a relatively fast and consistent polishing rate. ***EcoSite Bulk Fill*** also achieved the greatest depth of cure determined by two test methods among the materials tested. ***EcoSite Bulk Fill's*** combination of excellent polishability and high depth of cure highlights two exemplary properties for bulk-filled composites.

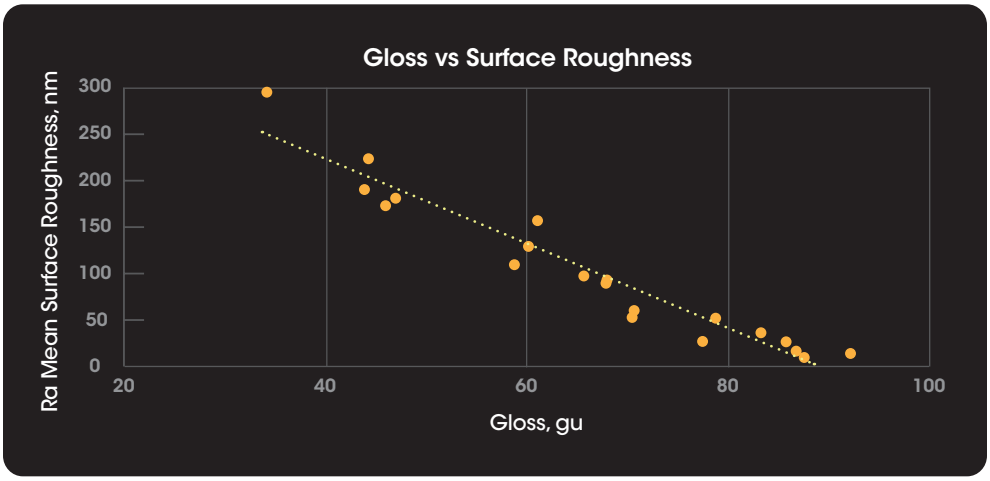
Results:

Polishing Time	10 Seconds		20 Seconds		30 Seconds		40 Seconds		Unlimited	
Units	Gloss, gu	Ra, nm	Gloss, gu	Ra, nm	Gloss, gu	Ra, nm	Gloss, gu	Ra, nm	Gloss, gu	Ra, nm
EcoSite Bulk Fill	43.9 (7.3)	191 (63)	60.2 (5.6)	130 (46)	70.5 (4.1)	54 (36)	77.5 (4.7)	28 (6)	87.6 (0.9)	14 (5)
Filtek One	47.0 (5.6)	182 (50)	67.9 (8.3)	91 (72)	78.8 (5.6)	53 (10)	85.8 (3.2)	28 (1)	92.2 (0.4)	15 (1)
SonicFill 2	44.3 (7.2)	224 (113)	61.1 (4.9)	158 (20)	68.0 (5.4)	94 (32)	70.7 (2.4)	61 (9)	83.3 (1.0)	38 (5)
Tetric EvoCeram Bulk Fill	34.2 (7.9)	295 (164)	46.0 (9.7)	174 (42)	58.8 (10.0)	111 (54)	65.7 (7.7)	98 (45)	86.8 (0.8)	18 (2)

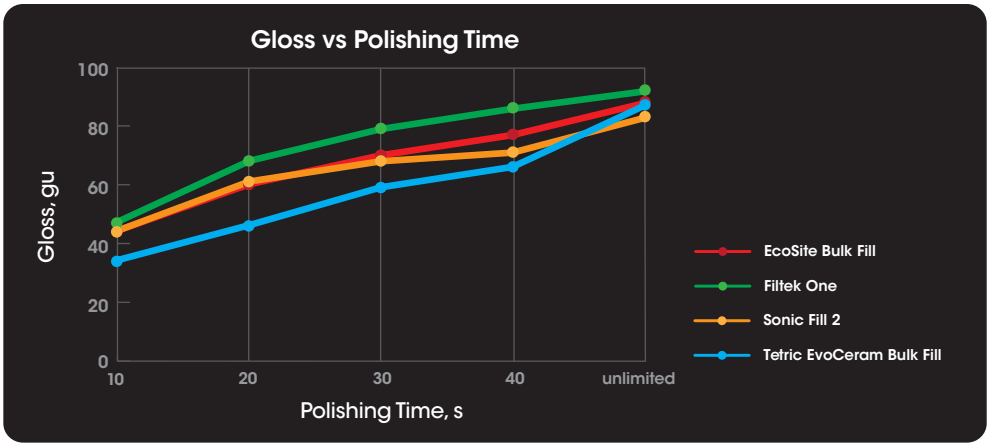
Product	ISO 4049 DoC, mm	Hardness Ratio DoC, mm	Top Surface Vickers Hardness, HV/0.1
EcoSite Bulk Fill	4.1 (0.1)	4.5	66.0 (0.9)
Filtek One	3.8 (0.0)	3.9	70.8 (1.4)
SonicFill 2	3.0 (0.0)	4.2	82.3 (1.9)
Tetric EvoCeram Bulk Fill	3.8 (0.1)	4.3	69.0 (2.4)



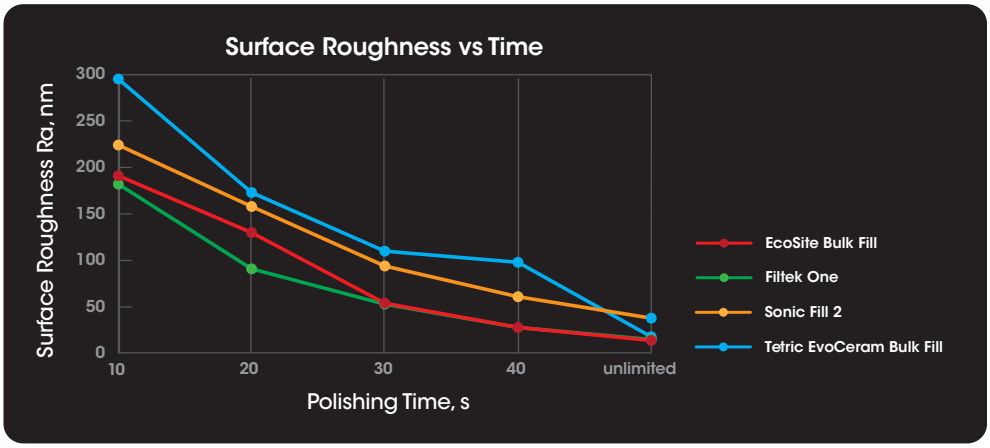
EcoSite Bulk Fill resulted in a higher depth of cure than the other products tested in both test methods used. There is a similar gradual drop in hardness for ***EcoSite Bulk Fill*** and ***Tetric EvoCeram Bulk Fil***l which may help reduce technique sensitivity in curing large restorations. ***SonicFill 2*** in particular had the steepest drop in hardness after 4 mm. ***SonicFill 2*** gave the largest variation in hardness readings depending on whether the indenter hit a filler particle >20 µm, rather than indenting mostly resin. This may lead to an overestimation of the hardness ratio at depth if the hardness value is derived more from filler content (which doesn't change at depth) than from hardness deriving from resin polymerization.



Linear regression was calculated using Microsoft Excel between gloss and surface roughness which found a R^2 =0.93 for a linear plot indicating a strong correlation between surface roughness and gloss.



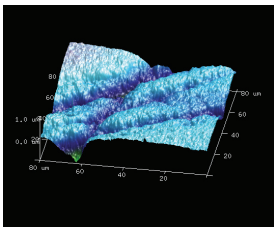
EcoSite Bulk Fill and **Filtek One** have similar polishing versus time curves which gave a steady increase in gloss with more time spent polishing. **Tetric EvoCeram Bulk Fill** required about 10 more seconds of polishing to achieve a similar result and the rate of increase in gloss began to plateau after 20-30 seconds for **SonicFill 2** and **Tetric EvoCeram Bulk Fill**.



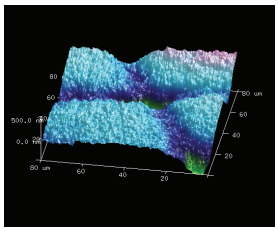
Filtek One consistently gives a larger gloss value than the surface roughness would predict indicating another variable, such as the refractive index of the zirconia filler particles results in a higher gloss value for a given surface roughness. Based on surface roughness evaluation of the polishing process, **EcoSite Bulk Fill** and **Filtek One** have an advantage over **SonicFill 2** and **Tetric EvoCeram Bulk Fill** in polishing time required.

Appendix:

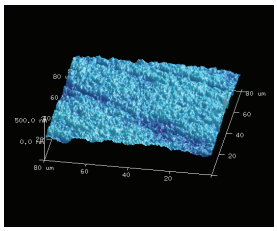
These are representative AFM images of the surface topography of each material at 10s, 20s, 30s, 40s and indefinite polishing times.



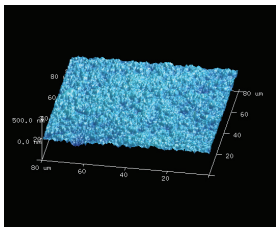
EcoSite Bulk Fill - 10 Seconds



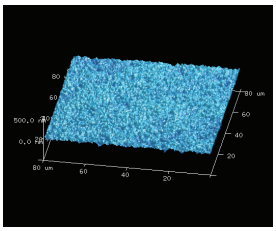
EcoSite Bulk Fill - 20 Seconds



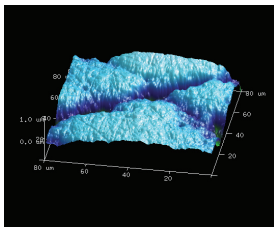
EcoSite Bulk Fill - 30 Seconds



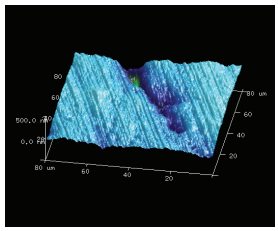
EcoSite Bulk Fill - 40 Seconds



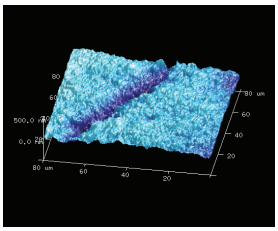
EcoSite Bulk Fill - Unlimited



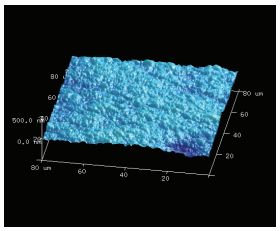
Filtek One - 10 Seconds



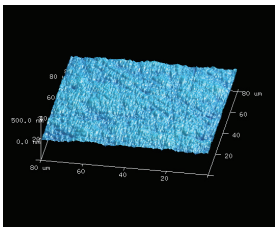
Filtek One - 20 Seconds



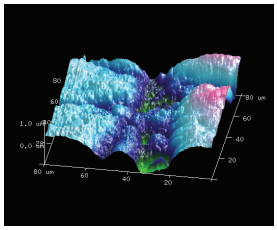
Filtek One - 30 Seconds



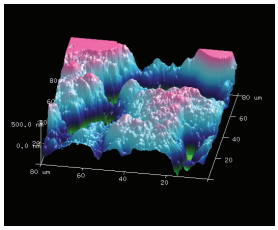
Filtek One - 40 Seconds



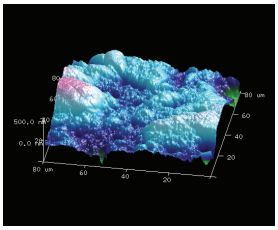
Filtek One - Unlimited



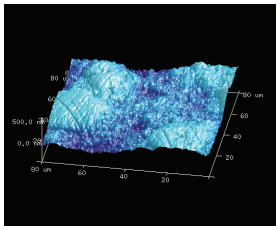
SonicFill 2 - 10 Seconds



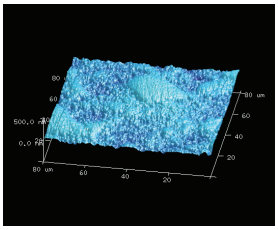
SonicFill 2 - 20 Seconds



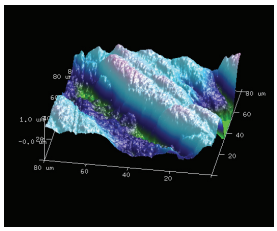
SonicFill 2 - 30 Seconds



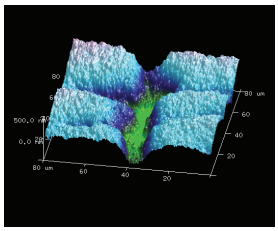
SonicFill 2 - 40 Seconds



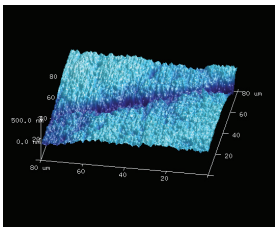
SonicFill 2 - Unlimited



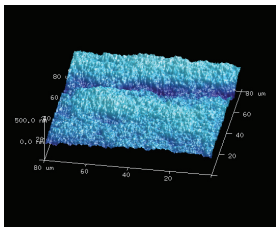
Tetric EvoCeram Bulk Fill - 10 Seconds



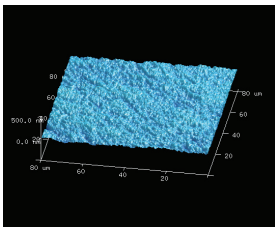
Tetric EvoCeram Bulk Fill - 20 Seconds



Tetric EvoCeram Bulk Fill - 30 Seconds



Tetric EvoCeram Bulk Fill - 40 Seconds



Tetric EvoCeram Bulk Fill - Unlimited