

Laboratory Evaluation of Bulk EZ[®], a Dual-Cure Bulk-Fill Flowable Composite

M. Cowen, J.M. Powers

Biomaterials Research Report

Matt Cowen, B.S.
DENTAL ADVISOR Biomaterials Research Center
3110 West Liberty, Ann Arbor, MI 48103
(734) 665-2020, ext. 111
matt@dentaladvisor.com



Number 123
February 12, 2019

Introduction:

Bulk-fill composites are designed to be cured in increments of 4 mm or more, which is a great time saver to the clinician. However, this often comes with a compromise in material properties such as strength, polishability and radiopacity. Likewise, flowable composites have an advantage of increased adaptation to cavity walls, which can reduce the occurrence of voids and microleakage, but also usually implies a compromise in other material properties in order to achieve a lower viscosity. **Bulk EZ** with Intellitek[®] technology is one of the first dual-cured, bulk-filled flowable composites which redefines what is possible by claiming an unlimited depth of cure while retaining important properties one should expect with permanent composite restoratives that will undergo occlusal forces. We tested these claims by measuring the flexural and compressive strength, depth of cure, radiopacity, and polishability.



Tests:

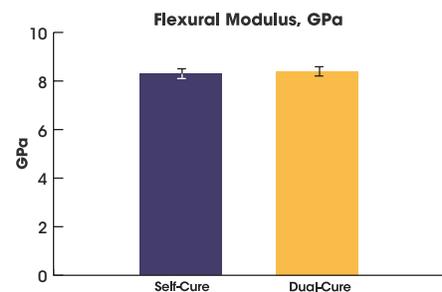
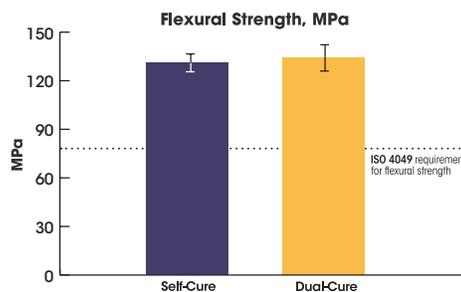
Flexural Strength:

Flexural strength was tested according to ISO 4049/ADA 27 specifications, which involve making 2 x 2 x 25 mm bar shaped specimens in a mold, and bending the specimens until they fail after curing for 24 hours. This test also describes how stiff the material is by measuring how much it bends with increasing load, and this is called the flexural modulus. As **Bulk EZ** claims an unlimited depth of cure, it is important that there is little difference in strength for especially deep preparations in which the curing light wouldn't reach. As such, we tested **Bulk EZ** with and without light curing to test how the self-curing properties affect the strength properties.

We found no significant difference in flexural strength or modulus with the addition of light curing. This is a fairly remarkable achievement as it is often the case that dual-cured resin-based materials improve in degree of polymerization with photopolymerization, which is usually reflected in either a change in stiffness or ultimate strength. **Bulk EZ also achieved a flexural strength of over 130 MPa, which few flowable composites are able to achieve, and well above the specification requirement of 80 MPa for polymer-based restoratives.**



Measuring flexural strength
on the Instron 5866.



Compressive Strength: 288 (7) MPa

We tested the compressive strength by forming 4 mm diameter by 8 mm long cylindrical specimens and loading in compression at 0.5 mm/min until failure. Compressive strength is especially important for resisting occlusal loading for materials designed to replace cusps. The majority of flowable bulk fill composites we have tested ranged from 250-340 MPa in compressive strength.

Radiopacity: 3.5 mm aluminum/1 mm of Bulk EZ

Radiopacity is defined by the apparent opacity of materials on radiographs. In the laboratory test, radiopacity is measured compared to a standard aluminum step-wedge, which has multiple thicknesses in order to establish a relationship between the opacity of the material compared to the thickness of aluminum. Aluminum is useful as a comparative material as 1 mm of aluminum is roughly equivalent to the radiopacity of 1 mm of dentin, and 2 mm of aluminum is equivalent to 1.8–2.0 mm of enamel. **We measured a radiopacity of 3.5 mm of aluminum per 1 mm of Bulk EZ, which makes it one of the most radiopaque flowable bulk fills on the market.** A high radiopacity allows the material to be easily distinguished from tooth structure on radiographs.

Depth of Cure: Unlimited

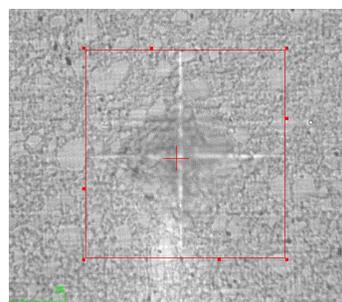
We tested the depth of cure by filling a 12 mm cylinder with **Bulk EZ**, light curing the top and comparing the hardness of the top and bottom surfaces with a Vicker's microhardness indenter. In depth of cure testing, the bottom surface is considered cured if the hardness is within 80% of the maximum surface hardness as the surface closest to the light exposure. The testing showed that the bottom surface was within 88% of the hardness as the top surface within 5 minutes, within 96% of the hardness after 30 minutes and within 98% of the top surface hardness after an hour. This showed that without light curing, **Bulk EZ** will achieve an acceptable cure within minutes, and as it continues to polymerize, the difference in the hardness between the top and bottom will continue to decrease. The average hardness after 24 hours was 58.8 kg/mm².

Gloss and Polishability:

Gloss is the measure of the amount of reflected light and is usually described as the luster or shininess of the surface. As well as an important property for esthetics, a high gloss can indicate a smoother surface, which can better resist staining and adhesion of microbes. **When cured against a smooth surface like Mylar or a matrix, Bulk EZ registered a high 93 gloss units (gu).** To measure polishability, we roughened the surface with 320-grit SiC paper to simulate adjustment with a fine bur, and then polished for 20 and 40 seconds. After 20 seconds of polishing, **Bulk EZ** achieved a clinically acceptable 70 gu with two different polishers (3M Filtek Soflex Diamond Polishing System and Kenda Polishette) and up to 80 gu with further polishing.

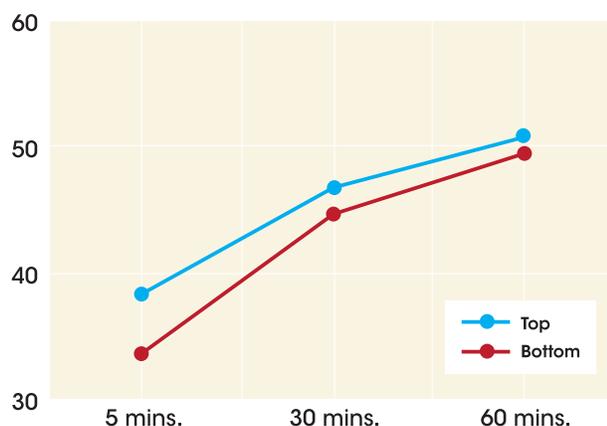


Measuring compressive strength on the Instron 5866.



Example indent after 30 minutes on the bottom surface.

Vickers hardness, HV/0.1



Conclusion: **Bulk EZ** has demonstrated exceptional properties, including high flexural strength, high radiopacity, high gloss after polishing and unlimited depth of cure.