

**Effect of light intensity and shade of material on depth of curing of bulk fill composite**

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**Abstract**

**Aim:** To compare the depth of curing of bulk-fill composite through different intensity light sources and different shades of the composite of varying thickness.

**Material & Methods:** Bulk-fill composite of various shades (A1, A2, A3, B2) and thickness (2,4,6, 8mm) were light-cured by two various intensity light cure units Ivoclar bluephase (1250) & Smartlite focus Dentsply (900) for 20 sec each. As per ISO 4049.2009, the depth of cure was measured.

**Result & Statistical analysis:** Depth of cure for darker shade was less than lighter shade using the same light cure. This was seen in intergroup and intragroup comparison.

The depth of curing for smartlite was more than Ivoclar bluephase when the same material and shade were used.

**Conclusion:** The shade of material and quality of the curing unit affects the depth of cure.

**Clinical Relevance:** In composite restoration, one should consider the shade of material as well as the quality of the light cure unit for a predictable outcome

**Keywords:** Depth of cure, light intensity, shades

**Introduction**

A major advantage of Resin-Based Composite (RBC) restoration is its esthetic properties and tooth color matching<sup>4</sup>. Different shades of RBC are available with different translucencies, to provide better shade matching with surrounding tooth structures, thus enhancing the esthetic of the restoration.

For darker shades in RBCs, some manufacturers have recommended increasing the light-curing time. This recommendation is evidenced and supported by several studies reporting an effect of the RBC shade on the degree of monomer convergence<sup>5</sup>. In 2009, Guiraldo et al. conducted an in vitro study of the effect of different Flitek Z250 RBC shades (A1, A2, A3, A3.5, and A4 vita shade guide) on the DC. They reported that darker shades exhibited lower microhardness than light shades.<sup>7</sup>

The manufacturers of bulk-fill resin-based composites (RBC) claim that it is possible to successfully photo cure 4 or even 5 mm increments of RBC instead of the customary 2 mm increment. While this approach may introduce fewer voids between each increment and reduce overall treatment times, the ability to adequately photo-cure such a large volume of RBC in one exposure is a concern.

Many types of light-curing units (LCUs) are available for the dentist to purchase. The homogeneity of the emitted light beam concerning the radiant emittance and spectrum of light across the RBC surface can affect the polymerization of the RBC.

To take light scattering into account, the composite measurements were compared to the blank measurements of the same height. Since the mono wave curing light is a collimated beam, as the distance increases the average irradiance should not change dramatically.

### **Method**

The Ivoclar bluephase light-curing unit has three different modes: High, Low, and Soft. The high program was chosen for this study to keep the Bluephase output comparable to the Smartlite Focus and to determine the maximum light going thru the composite<sup>1</sup>. The time chosen for the curing cycle was 20 seconds due to manufacturer recommendations and the fact that the SmartLite Focus can only be set to cure for twenty seconds.

Ivoclar bulk-fill composite of various shades (A1, A2, A3, and B2) and thickness (2,4,6, 8mm) were light-cured by two various intensity light cure units Ivoclar bluephase (1250) & Smartlite focus Dentsply (900) for 20 sec each. as per ISO 4049<sup>9</sup>.2009 depth of cure was measured.

### **Requirements**

1. Composite of various shades (A1, A2, A3 & B2)
2. light-curing unit
3. Plastic molds having molds of 2,4,6 and 8 mm depth
4. glass slab
5. plastic filling instrument
6. spatula or scalpel
7. Calliper

### **Step by step procedure**

1. Place the mold on the glass slab and fill it with composite.
2. Light-cure the composite for 20 sec
3. Remove the cured material from the mold.
4. Peel off the uncured material from the bottom side of the sample using the spatula or scalpel.
5. Measure the remaining thickness of the sample and divide this number by two. The ISO 4049 standard requires that the result should be at least 1.5 mm for non-opaque shades and 0.5 mm for opaque shades.
6. Repeat and measure the depth of cure by using another curing unit with the same shade & material.
7. Repeat the procedure and measure the depth of cure by using a different shade of composite material and for different curing units also.

**Result & Statistical Analysis**

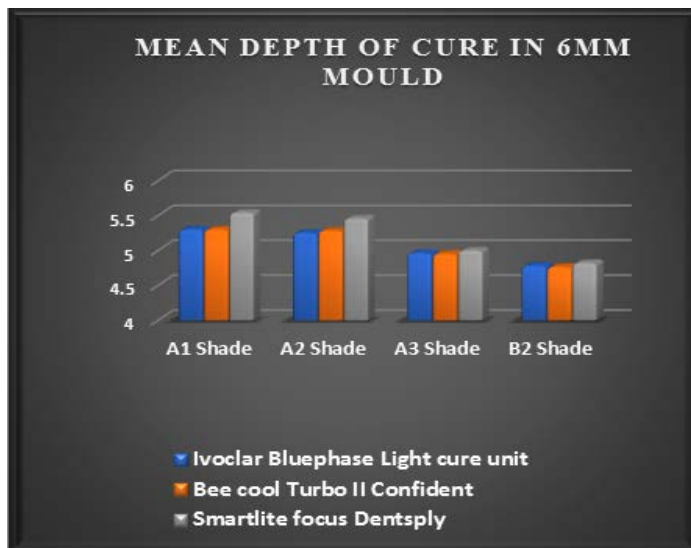
Smart lite Focus Dentsply

Thickness of material	Uncured Depth		
	A1 (mm)	A2	A3
2mm	0	0	0
4mm	0	0	0
6mm	.5	.5	1.0
8mm	2	2.3	2.5

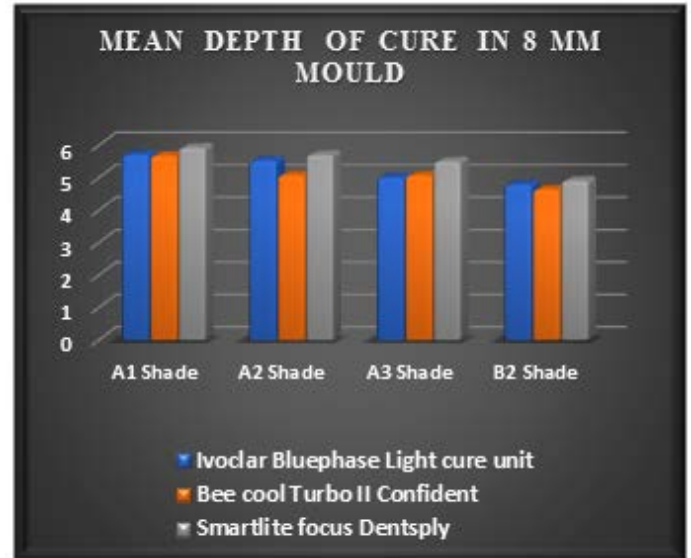
Thickness of material	Uncured Depth		
	A1 (mm)	A2	A3
2mm	0	0	0
4mm	0	0	0
6mm	.5	.5	1.0
8mm	2	2.3	2.5

Blue phase Ivoclar- high

Depth of cure for darker shade was less than lighter shade using the same light cure. This was seen in intergroup and intragroup comparison. Depth of curing for Smartlite Focus was more than Ivoclar Bluephase when the same material and shade were used.



Graph 1



Graph 2

**Discussion**

Increasing the RBC restoration thickness results in more curing light absorption and scattering and less light penetration within the layers of the cured material. Therefore, overall curing light energy is reduced with increasing RBC thickness. Accordingly, the DC value of the material is also reduced<sup>6</sup>. Therefore, for cavity preparation exceeding 2 mm, the incremental layering technique is considered a standard of care of RBC placement. This technique reportedly allows sufficient light exposure of the RBC layers and lower polymerization shrinkage<sup>8</sup>. On the other hand, the 2 mm increment layering technique is considered time-consuming. Therefore, another category of RBCs has been introduced with composition modifications, which allow adequate DC of the RBCs in a thicker increment (i.e., 4 mm thick). These are Bulk fill composites.

**Depth of cure**

Determining in vivo whether or not a composite is completely cured remains a challenge for dentists. The uppermost layer is seen to be hard, however, deeper layers are invisible and may remain unpolymerized. The more

translucent and lighter colored a composite, the greater the light penetration and therefore depth of cure. There are a number of ways to establish the depth of cure (in vitro) in dental materials. The international standard ISO 4049 for polymer-based restorative materials suggests measuring the depth of cure via preparing cylindrical specimens 6 mm long and 4 mm wide, or if a depth of cure greater than 3 mm is claimed, the length should be at least 2 mm longer than twice the claimed depth of cure<sup>10</sup>. After curing according to the manufacturer's instructions, the material is removed from its mold, the inhibition layer and other uncured material are scraped away and the height of the remaining material is measured. This value (divided by 2) is considered to be the depth of cure.

The two dental units being tested are the poly wave Bluephase G2 by Ivoclar Vivadent and the mono wave SmartLite Focus by Dentsply.

The SmartLite Focus is a mono wave with only one curing cycle with consistent irradiance for 20 seconds<sup>3</sup>. Unlike the Bluephase G2, it has only one LED and delivers light to the composite in a collimated beam supposedly resulting in less scatter and deeper depth of cure (up to 8mm).<sup>2</sup> The emission spectrum of the LED is directed towards the absorption spectrum of camphorquinone with an emission range from around 380nm-500nm (around the same as the G2) with one peak at around 465nm. There is no second peak meant to overlap the absorption spectrum of Lucirin TPO. According to the manufacturer, SmartLite has a 79.7% efficiency of initiating camphorquinone concerning the 70.4-77.8% efficiency of the Bluephase G2. Furthermore, its beam is more evenly distributed than the poly wave. The light output of the SmartLite is approximately at 1,100±10% per studies done by the manufacturer, which is the same as the G2

## Conclusion

In conclusion, although 2 mm incremental thickness is still the regular standard for RBC increment placement<sup>11,12</sup>, using bulk-fill allows placement of RBCs in more than 2 mm increments (up to 4 mm) while maintaining an adequate DC. This is due to higher light transmission through the more translucent bulk-fill RBC thickness when compared to conventional RBCs

For both lights, the difference in transmittance between different thicknesses went down as the thickness of the composite increased. This indicates that the thicker the composite the less light will reach the photoinitiators on the bottom which should result in a lower level of cure the deeper you go into the composite.

The shade of material and quality of the curing unit affects the depth of cure.

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