# Light curing. Are all LED light devices the same?

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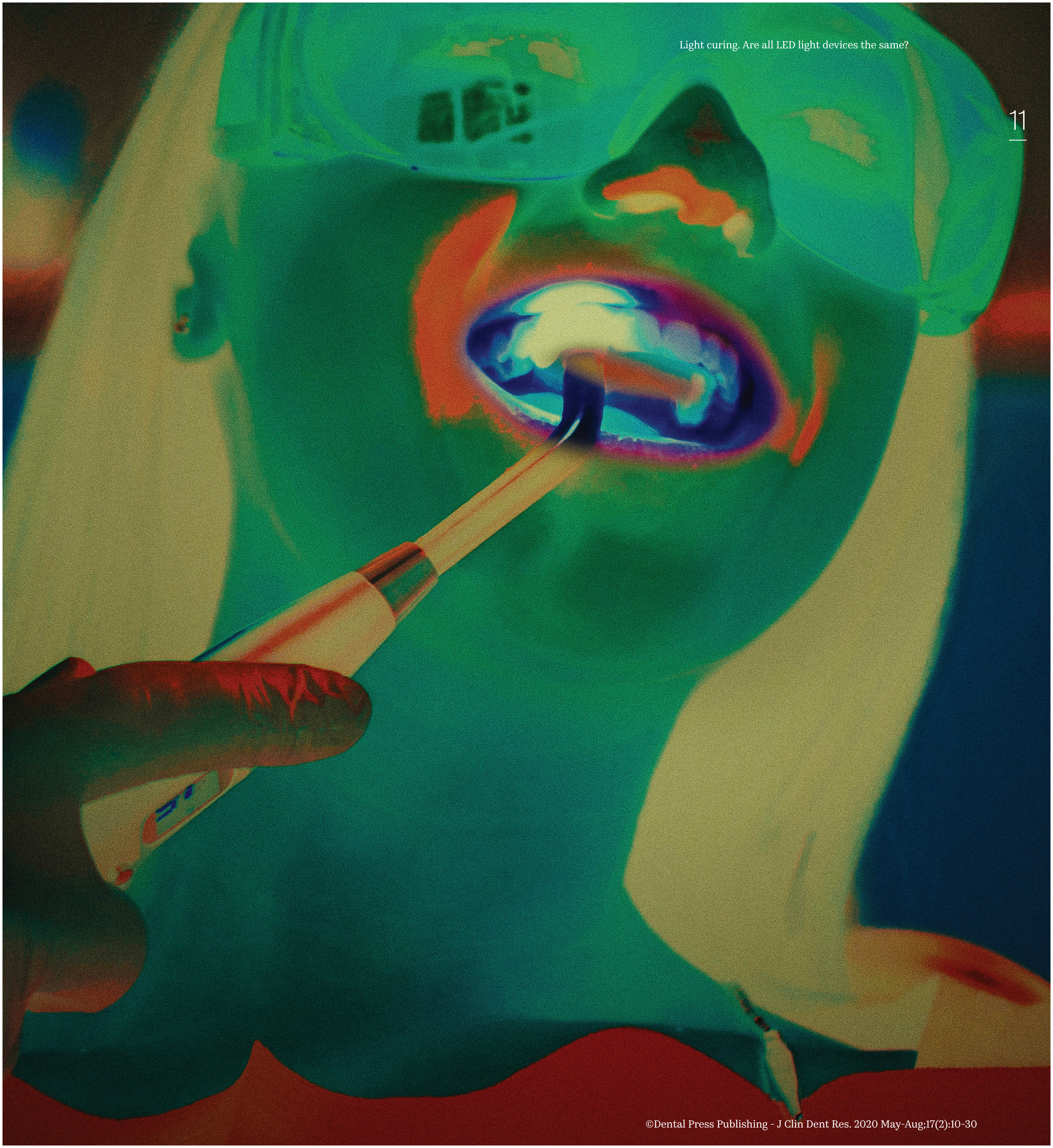

*In this edition of the **Highlights** section, we will address a fundamentally important topic about adhesive and restorative procedures sucess, the **Photopolymerization**. We are a **dependent "LED"** generation, since most of the procedures that we commonly perform, regardless of the clinical area, depends on some type of light source for the polymerization of materials.*

*In this way, knowledge about this polymerization process is essential to ensure the safety and longevity of our procedures. For a long time, it was common to discuss through evidence regarding more common issues such as adhesion, composite resin and cementation. However, very little was discussed about the light apparatus for photopolymerization or photoactivation.*

*Allied to this fact, there is a need to expose important information based on evidence and directed to the clinician, so that photopolymerization is known and discussed in a conscious manner, thus managing to give due emphasis to this topic so essential nowadays.*

*Thus, we have gathered some of the main published scientific articles, which addressed the topic of **light curing, specially for composite resins**, to develop a critical and interpretive analysis of the evidence available in the literature.*

The **first article** is a critical review of the literature, which addressed the main aspects of photopolymerization. The article was published in ***Brazilian Oral Research*** in 2017.

## LIGHT CURING IN DENTISTRY AND CLINICAL IMPLICATIONS: A LITERATURE REVIEW

*Rueggeberg FA, Giannini M, Arrais CAG, Price RBT*

*Braz Oral Res. 2017 Aug 28;31(suppl 1):e61. doi: 10.1590/1807-3107bor-2017.vol31.0061*

### ABSTRACT

Contemporary dentistry literally cannot be performed without use of resin-based restorative materials. With the success of bonding resin materials to tooth structures, an even wider scope of clinical applications has arisen for these lines of products. Understanding of the basic events occurring in any dental polymerization mechanism, regardless of the mode of activating the process, will allow clinicians to both better appreciate the tremendous improvements that have been made over the years, and will also provide valuable information on differences among strategies manufacturers use to optimize product performance, as well as factors under the control of the clinician, whereby they can influence the long-term outcome of their restorative procedures.

### COMMENTS:

This review efficiently addresses virtually all-important parameters for understanding the polymerization process of restorative materials. The authors divided the articles by topics, starting the discussion through the Polymerization process. In dentistry, almost all resin-based restorative products use the same family of monomers and the same polymerization mechanism. The most common monomers are those based on methacrylates and vinyl, which are organic matter, composed of carbon, which will compose a polymeric chain after polymerization. This concept of dental materials for the clinician, perhaps it would not be so applicable, as long as the clinician strictly follows a correct photopolymerization protocol. However, understanding the monomeric conversion of the resin is essential information for those who study and disseminate information about restorative procedures. Another topic very well addressed in the article is related to Photoinitiators. The most commonly used initiator in composite resins is camphorquinone (CQ), which absorbs energy in a spectrum of visible blue light, between 400 to 500nm, with the peak of the ideal wavelength at 468nm. The energy (photons) will be absorbed by the molecule, which will pass to the excited state, creating a free radical that will bind to the monomer, thus forming a chain reaction. However, camphorquinone is an intense yellow substance, limiting its use in whiter or translucent resins. For this reason, some manufacturers have introduced in cement or composite resins the partial or total replacement of camphorquinone by other photoinitiators. However, the most common light-curing devices do not emit lights at a wavelength capable of effectively sensitizing other photoinitiators, such as TPO (trimethylphosphine oxide), BAPO (bis-alkyl phosphine oxide) and IVOCERIN (benzoyl germanium), which mainly absorb light in the violet spectrum, instead of light in the blue spectrum, as the QC does. As the clinician does not always have the information of the photoinitiator used in the material being used, it is recommended to use a light device that emits different wavelengths, known as POLYWAVE. MONOWAVE are restricted to only one wavelength. Another interesting comment about the article is related to the concepts of Irradiance, Power and Energy. Device power is measured in mW and, regardless of the transmitting tip area of the device. Irradiance, on the other hand, is the power of the LED divided by the exit area of the tip of the photoactivator being measured in $mW/cm^2$. Most composite resins need to receive approximately 16 $Joules/cm^2$ of energy dose, for polymerization. Thus, the energy dose can be calculated between the time of light exposure multiplied by the irradiance of the photopolymerizer used. Thus we were able to understand why in the past we learned to polymerize composite resin for 40 seconds, since halogen light devices had an irradiance of around 400 $mW/cm^2$. Currently, a good LED device has a minimum power of more than 800 mW, which is why we recommend 20 seconds of light curing.

The **second article** addresses the effect of different wavelengths on the photopolymerization of a composite with 2 different photoinitiators. The article was published in ***Dental Materials*** in 2017.

## EFFECT OF BLUE AND VIOLET LIGHT ON POLYMERIZATION SHRINKAGE VECTORS OF A CQ/TPO-CONTAINING COMPOSITE

*Sampaio CS, Atria PJ, Rueggeberg FA, Yamaguchi S, Giannini M, Coelho PG, Hirata R, Puppin-Rontani RM*

*Dent Mater. 2017 Jul;33(7):796-804*
*doi: 10.1016/j.dental.2017.04.010*
*Epub 2017 May 15*

**OBJECTIVE**

To evaluate the effect of light-curing wavelengths on composite filler particle displacement, and thus to visualize localized polymerization shrinkage in a resin-based composite (RBC) containing camphorquinone (CQ) and Lucirin TPO (TPO).

**METHODS:**

Three light-curing units (LCUs) were used to light-cure a RBC containing CQ and TPO: a violet-only, a blue-only, and a dual-wavelength, conventional (Polywave®, emitting violet and blue wavelengths simultaneously). Zirconia fillers were added to the RBC to act as filler particle displacement tracers. LCUs were characterized for total emitted power (mW) and spectral irradiant output (mW/cm$^2$/nm). 2-mm high, 7-mm diameter silanized glass cylindrical specimens were filled in a single increment with the RBC, and micro-computed tomography (µ-CT) scans were obtained before and after light-curing, according to each LCU (n=6). Filler particle movement identified polymerization shrinkage vectors, traced using software, at five depths (from 0 up to 2mm): top, top-middle, middle, middle-bottom and bottom.

**RESULTS:**

Considering different RBC depths within the same LCU, use of violet-only and conventional LCUs showed filler particle

movement decreased with increased depth. Blue-only LCU showed homogeneous filler particle movement along the depths. Considering the effect of different LCUs within the same depth, filler particle movement within LCUs was not statistically different until the middle of the samples ($P>.05$). However, at the middle-bottom and bottom depths (1.5 and 2mm, respectively), blue-only LCU compared to violet-only LCU showed higher magnitude of displacement vector values ($P<.05$). Use of the conventional LCU showed filler displacement magnitudes that were not significantly different than blue-only and violet-only LCUs at any depth ($P>.05$). With respect to the direction of particle movement vectors, use of violet-only LCU showed a greater displacement when close to the incident violet LED; blue-only LCU showed equally distributed particle displacement values within entire depth among the samples; and the conventional LCU showed greater filler displacement closer to the blue LED locations.

**SIGNIFICANCE:**

Filler particle displacement in a RBC as a result of light-curing is related to localized application of light wavelength and total emitted power of the light emitted on the top surface of the RBC. When the violet LED is present (violet-only and conventional LCUs), filler particle displacement magnitude decreased with increased depth, while results using the blue-only LED show a more consistent pattern of displacement. Clinically, these results correlate to production of different characteristics of curing within a RBC restoration mass, depending on localized wavelengths applied to the irradiated surface.

**COMMENTS:**

In this study, the authors used the Bluephase 20i (Ivoclar) curing light. The manufacturer supplied the devices, with the Violet light only, Blue light only, and conventional (Blue and Violet) mode. The authors observed that the experimental devices had different patterns of emitted power and output irradiance through the ends of the device's tips, which influenced the displacement of the charge particles, and thus, the determination of the polymerization contraction vectors in relation to various depths in a resin with QC and TPO. The LCU with only violet color demonstrated a magnitude of displacement of charge particles of the same order of magnitude as that of the blue device only and with conventional LCUs (violet and blue emissions simultaneously) to a depth of approximately 1mm. With increasing depth (1.5-2mm), violet light (only violet and conventional LCUs) produced less particle displacement filling, indicating lower polymerization values. The depth of light curing of the resin when using the light curing method only with violet decreases with the increase of the depth of a 2mm sample, compared to the use of a blue LCU. Therefore, the use of a non-homogeneous LCU affects the three-dimensional polymerization kinetics of a restoration. Clinically, the different polymerization patterns within a restoration mass could be translated into non-uniform mechanical properties throughout the restoration body.

The **third article** analyzed the influence of irradiance on the polymerization of different types of composite resin. The article was published in ***Operative Dentistry***, in 2017.

## INFLUENCE OF EMISSION SPECTRUM AND IRRADIANCE ON LIGHT CURING OF RESIN-BASED COMPOSITES

*Shimokawa C, Sullivan B, Turbino ML, Soares CJ, Price RB*

*Oper Dent. 2017 Sep/Oct;42(5):537-547. doi: 10.2341/16-349-L. Epub 2017 Jun 5.*

**OBJECTIVE**

This study examined the influence of different emission spectra (single-peak and broad-spectrum) light-curing units (LCUs) delivering the same radiant exposures at irradiance values of 1200 or 3600 mW/cm$^2$ on the polymerization and light transmission of four resin-based composites (RBCs).

**METHODS AND MATERIALS:**

Two prototype LCUs that used the same light tip, but were either a single-peak blue or a broad-spectrum LED, were used to deliver the same radiant exposures to the top surfaces of the RBCs using either standard (1200 mW/cm$^2$) or high irradiance (3600 mW/cm$^2$) settings. The emission spectrum and radiant power from the LCUs were measured with a laboratory-grade integrating sphere coupled to a spectrometer, and the light beam was assessed with a beam profiler camera. Four RBCs (Filtek Supreme Ultra A2, Tetric EvoCeram A2, Tetric EvoCeram T, and TPH Spectra High Viscosity A2) were photoactivated using four different light conditions: single-peak blue/standard irradiance, single-peak blue/high irradiance, broad-spectrum/standard irradiance, and broad-spectrum/high irradiance. The degree of conversion (N=5) and microhardness at the top and bottom of 2.3-mm-diameter by 2.5-mm-thick specimens (N=5) were analyzed with analysis of variance and Tukey tests. The real-time light transmission through the RBCs was also measured.

**RESULTS:**

For all light conditions, the 2.3-mm-diameter specimens received a homogeneous irradiance and spectral distribution. Although similar radiant exposures were delivered to the top surfaces of the RBCs, the amount of light energy emitted from the bottom surfaces was different among the four RBCs, and was also greater for the single-peak lights. Very little violet light (wavelengths below 420 nm) reached the bottom of the 2.5-mm-thick specimens. The degree of conversion and microhardness results varied according to the RBC ($p<0.05$). The RBCs that included alternative photoinitiators had greater microhardness values at the top when cured with broad-spectrum lights, while at the bottom, where little violet light was observed, the results were equal or higher when they were photoactivated with single-peak blue lights. With the exception of the microhardness at the top of TPH, equivalent or higher microhardness and degree-of-conversion values were achieved at the bottom surface when the standard (1200 $mW/cm^2$) irradiance levels were used compared to when high irradiance levels were used.

**CONCLUSIONS:**

Considering the different behaviors of the tested RBCs, the emission spectrum and irradiance level influenced the polymerization of some RBCs. The RBCs that included alternative photoinitiators produced greater values at the top when cured with broad-spectrum lights, while at the bottom, results were equal or higher for the RBCs photoactivated with single-peak blue lights.

**COMMENTS:**

The clinical applicability of this article refers to professionals, who should be aware that, large spectrum LED polymerization lights (blue and violet or POLIWAVE) can improve the properties on top of a restoration made with composite resin that contain photoinitiators “alternative”, the use of these lights could result in lower properties at the bottom, since little violet light reaches this area of the restoration, thus recommending the professional not to work with very large increments in thickness. In this article, the researchers used an LED device provided by Ultradent. We believe that in summary, the authors were able to conclude that the emission spectra of LCUs influenced the polymerization of the tested composite resins. The microhardness of materials that used alternative photoinitiators in their composition was improved on the upper surface with the use of broad spectrum lights (Poliwave). However, this effect was lost on the lower surface, where little violet light was observed. In addition, different shades of the same brand allowed different amounts of light to reach the bottom Resin. Even when the same radiant exposure was provided, the levels of irradiation influenced the polymerization of the tested resins. Equivalent or higher values of microhardness and degree of conversion were achieved on the bottom surface when 1200 mW/cm$^2$ was used, compared to 3600 mW/cm$^2$.

The **fourth article** makes a very interesting observation, as it analyzes the behavior of polymerization when there is a distance from the source of light emission to the composite resin. The article was published in ***Brazilian Oral Research*** in 2015.

## CHANGES IN IRRADIANCE AND ENERGY DENSITY IN RELATION TO DIFFERENT CURING DISTANCES

*Beolchi RS, Moura-Netto C, Palo RM, Rocha Gomes Torres C, Pelissier B*

*Braz Oral Res. 2015;29*
*pii: S1806-83242015000100257*
*doi: 10.1590/1807-3107BOR-2015.vol29.0060*

**ABSTRACT**

The present study aimed to assess the influence of curing distance on the loss of irradiance and power density of four curing light devices. The behavior in terms of power density of four different dental curing devices was analyzed (Valo, Elipar 2, Radii-Cal, and Optilux-401) using three different distances of photopolymerization

(0 mm, 4 mm, and 8 mm). All devices had their power density measured using a MARC simulator. Ten measurements were made per device at each distance. The total amount of energy delivered and the required curing time to achieve 16 J/$cm^2$ of energy was also calculated. Data were statistically analyzed with one-way analysis of variance and Tukey's tests ($p < 0.05$). The curing distance significantly interfered with the loss of power density for all curing light devices, with the farthest distance generating the lowest power density and consequently the longer time to achieve an energy density of 16 J/$cm^2$ ($p < 0.01$). Comparison of devices showed that Valo, in extra power mode, showed the best results at all distances, followed by Valo in high power mode, Valo in standard mode, Elipar 2, Radii-Cal, and Optilux-401 halogen lamp ($p < 0.01$). These findings indicate that all curing lights induced a significant loss of irradiance and total energy when the light was emitted farther from the probe. The Valo device in extra power mode showed the highest power density and the shortest time to achieve an energy density of 16 J/$cm^2$ at all curing distances.

**COMMENTS:**

This article reinforces the concept that we analyzed in the first article presented in this section. One of the most important elements that must be considered in photoactivating devices is the power density (mW / $cm^2$), also called irradiance or luminous intensity. The concept of total energy attests that the photopolymerization process depends on the energy absorbed by the resin and can be summarized by multiplying the light intensity by the exposure time. We have already seen that the resin needs at least an energy of 16 cages, so it is not enough for the device to have good irradiance when in direct contact with the resin. This device cannot significantly lose its luminous intensity when faced with situations that do not allow direct contact with light, such as, for example, in a deep Class II, this loss of intensity will have to be rewarded by the exposure time. All the light curing devices tested had a significant loss of radiation and total energy when the light was emitted farther, at a distance of 8 mm. Consequently, the average time to reach a total energy density of 16 J / $cm^2$ increased significantly as the distance from the tip to the sensor increased. In other words, we would need much more time beyond the usual 20 seconds that we use to light cure the composite resin, with some light curing agents, in situations that do not allow direct access to the Led tip. When comparing the devices, it was observed that Valo in the extra power mode showed the best irradiance results at all distances, followed by Valo in the high power mode, Valo in the standard mode, Elipar 2, Radii-Cal, and Optilux -401 halogen lamp.

In view of these deeper cavities, which hinder polymerization, the **fifth article** analyzes the effect of different photopolymerizers in different Bulk fill composite resin systems, which are recommended resins in wide and deep cavities. The article was published in ***Dental Materials*** in 2018.

## EFFECT OF LIGHT CURING UNITS ON THE POLYMERIZATION OF BULK FILL RESIN-BASED COMPOSITES

*Shimokawa CAK, Turbino ML, Giannini M, Braga RR, Price RB*

*Dent Mater. 2018 Aug;34(8):1211-1221.*
*doi: 10.1016/j.dental.2018.05.002.*
*Epub 2018 May 22.*

**OBJECTIVE**

To determine the potential effect of four different light curing units (LCUs) on the curing profile of two bulk fill resin-based composites (RBCs).

**METHODS:**

Four LCUs (Bluephase 20i, Celalux 3, Elipar DeepCure-S and Valo Grand) were used to light cure two RBCs (Filtek Bulk Fill Posterior Restorative and Tetric EvoCeram Bulk Fill). The effective tip diameter, radiant power, radiant emittance, emission spectrum and light beam profile of the LCUs were measured. Knoop microhardness was measured at the top and bottom surfaces of RBC specimens that were 12-mm in diameter and 4-mm deep (n=5). The distribution of the spectral radiant power that was delivered to the surface of the specimen and the light transmission through the 4-mm thick specimens was measured using an integrating sphere. Two-way ANOVA and Tukey tests ($\alpha$=0.05) were applied.

**RESULTS:**

The Valo Grand produced the most homogeneous microhardness across the surfaces of the RBCs (p>0.05). When the Celalux 3, Bluephase 20i and Elipar DeepCure-S lights were used, the center of the specimens achieved greater hardness values compared to their outer regions (p<0.05). Approximately 10% of the radiant power delivered to the top reached the bottom of the specimen, although almost no violet light passed through 4mm of either RBC. A positive correlation was observed between the radiant exposure and microhardness.

**SIGNIFICANCE:**

The characteristics of the LCUs influenced the photoactivation of the RBCs. The use of a wide tip with a homogeneous light distribution is preferred when light curing RBCs using a bulk curing technique.

**COMMENTS:**

Upon reading the findings of this article, considering the results obtained, the

power of the device, the diameter of the active tip and light beam profile are characteristics of the devices that must be communicated by both manufacturers and researchers. As very little violet light strikes the bottom of the 4 mm thick restorations, the 4 mm deep polymerization must not depend only on photoinitiators that are activated by the lower wavelengths of violet light. In addition, dentists should be advised when purchasing and using suitable light-curing devices that have good light, a wide light output tip, which provides uniform irradiance and wavelengths for the entire composite resin body. In this study using the four LCU and the two Bulkfill resins, he observed that the different tip diameters and the irradiance of the devices significantly influenced the photopolymerization of the composites. It is recommended to use an LCU that has a wide light output tip, as it allows irradiance emission and more uniform light wavelengths for the entire surface and body of the resin. Smaller tips can provide non-homogeneous distribution of irradiance and light wavelengths, thus influencing the polymerization of the resin, especially at the ends.

Concerned with cordless light curers, the sixth article evaluates the influence of the battery level on effectiveness of photopolymerization. The article was published in ***Operative Dentistry***, in the year 2020.

## INFLUENCE OF DIFFERENT CORDLESS LIGHT-EMITTING-DIODE UNITS AND BATTERY LEVELS ON CHEMICAL, MECHANICAL, AND PHYSICAL PROPERTIES OF COMPOSITE RESIN

*Cardoso IO, Machado AC, Teixeira D, Basílio FC, Marletta A, Soares PV*

*Oper Dent. 2020 Jul 1;45(4):377-386*
*doi: 10.2341/19-095-L*

**ABSTRACT**

The aim of this study was to evaluate the influence of different light-emitting diode (LED) curing units and battery levels on the chemical, mechanical, and physical properties of composite resins. The irradiance for each cycle from full to completely discharged battery level was evaluated, for five different new cordless LED units: Optilight Color (Gnatus), Bluephase (Ivoclar), Valo (Ultradent), Radii Plus (SDI), and Radii Xpert (SDI). After the irradiance evaluation, composite resin specimens were prepared and light cured, while varying the battery level for each LED unit: high level (HL, 100%), medium level (ML, 50%), and low level (LL, 10%). The degree of conversion, diametral tensile strength, sorption, and solubility were also evaluated. Data were checked for homoscedasticity and submitted to two-way and three-way analysis of variance, depending on the test performed, followed

by the Tukey test with a significance level of 95%. A negative correlation was found between irradiance and cycles of light curing, which was checked by the Pearson correlation test. Valo and Radii Xpert were not influenced by the battery level in any test performed. Valo and Radii Xpert were not influenced by the battery level in any test performed. However, different battery levels for some LED units can influence the degree of conversion, diametral tensile strength, sorption, and solubility of composite resins.

**COMMENTS:**

This article assesses the influence of different LED units and the battery level on the properties of resin composite (RC). The investigation of the influence of the battery level on the properties of the RC is very interesting, as this information is not available by the manufacturer in the product information, such as the power, and the types of polymerization cycles. Of the five LEDs analyzed, the authors found that for Valo and Radii Xpert there was no variation in the properties analyzed when varying the battery level in high, medium and low. In the other three LEDs, there was a reduction in the energy intensity emitted by the devices and a reduction in some properties when varying from high to low level. So the authors recommend using the best LED devices and always using your device with a high battery level.

This becomes very important, as the LED can negatively influence the performance of your clinical procedures, even if all care is taken with the other clinical variables.

The **seventh article** evaluates two photopolymerization protocols for Bulk-fill resins. The article was published in **Journal Mechanical Behavior Biomedical Materials** in 2019.

## EFFECT OF LIGHT-CURING PROTOCOLS ON THE MECHANICAL BEHAVIOR OF BULK-FILL RESIN COMPOSITES

*Besegato JF, Jussiani EI, Andrello AC, Fernandes RV, Salomão FM, Vicentin BLS, Dezan-Garbelini CC, Hoeppner MG*

*J Mech Behav Biomed Mater. 2019 Feb; 90:381-387.*
*doi: 10.1016/j.jmbbm.2018.10.026*

**OBJECTIVE**

To investigate the effect of two light-curing protocols on mechanical behavior of three bulk-fill resin composites (BFRC) considering their optical properties.

**METHODS:**

One increment of 4 mm thickness of the bulk-fill resin composites Opus Bulk Fill, Tetric N-Ceram and Filtek Bulk Fill Flow were submitted to two different light-curing protocols: Sp - irradiance of 1000 mW/cm2 (20 s); Xp - irradiance of 3200 mW/cm2 (6 s). To assess the influence on the mechanical behavior it was studied polymerization shrinkage by X-ray microtomography (n = 3), Vickers hardness (n = 10) at the top and bottom surfaces of the samples, irradiance reaching the bottom surface (n = 3) and absorbance spectrum during the light-curing time interval (n = 3). Data were analyzed by two-way ANOVA test for parametric data and Kruskal Wallis test, followed by Wilcoxon or Mann-Whitney U post-test, for non-parametric data.

**RESULTS:**

All BFRCs contracted when light-cured, with greater contraction for Xp. Filltek Bulk Fill Flow showed highest polymerization shrinkage, for both Sp and Xp. All BFRCs showed minor hardness values on the bottom surface, with greater reduction for Xp. All BFRCs exhibited a decrease in irradiance at 4 mm depth. A decrease

in absorbance intensity throughout the light-cure was observed, except for Opus Bulk Fill.

## CONCLUSIONS:

Regardless BFRCs composition, the light-curing protocol with lower irradiance and longer exposure time results in lower polymerization shrinkage and higher hardness. The higher irradiance in a shorter time interval compromises the mechanical behavior of the resin composites, which may result in undesirable clinical outcomes.

## COMMENTS:

Recently, there has been a great demand for high power LED devices in order to improve the performance of adhesive procedures. However, this study, when evaluating the influence of polymerization protocols of 1000W (20s) and 3200W (6s), observed that if the exposure of single-increment resins is done with high power (3200W), there will be a compromise of the mechanical properties of these materials, so less power should be used with a longer exposure time. However, the authors still raise the question that in 4mm increments, the final portion of the resins used did not reach complete polymerization in any of the protocols used, with none of the LED devices. Based on this study, it seems that the protocol to achieve the ideal polymerization of single-increment resins still needs to be improved.

Finally, the **eighth article** reviews the factors that could influence the power of density of photopolymerizers. The article was published in the **American Journal Dentistry** in 2018.

## FACTORS INFLUENCING SUCCESS OF RADIANT EXPOSURE IN LIGHT-CURING POSTERIOR DENTAL COMPOSITE IN THE CLINICAL SETTING

*Maktabi H, Balhaddad AA, Alkhubaizi Q, Strassler H, Melo MAS*

*Am J Dent. 2018 Dec;31(6):320-328*

**OBJECTIVE**

(1) To conduct a comprehensive review of the literature on factors influencing the radiant exposure of resin-based composite (RBC) restorations and (2) To fully understand the appropriate way of using the light curing units (LCUs) to perform restorations with optimal mechanical/physical properties.

**METHODS:**

A PubMed search identified recent publications in English that addressed the factors affecting the longevity of the RBC restorations and the optimal usage of LCUs.

**RESULTS:**

RBCs require light-induced polymerization of methacrylate monomers present in its composition to reach acceptable mechanical and physical properties. Complete polymerization of the RBC is never reached, and the maximum degree of conversion (DC) varies from 40 to 80%. The amount of radiant exposure (Joules/cm²) required for the commencement of polymerization becomes a core driver for the quality of the RBCs. Insufficient radiant exposure may lead to low strength behavior and susceptibility to degradation, thereby shortening the lifespan of restorations inside the mouth. This suggests that there are factors affecting the radiant exposure during clinical procedures; these factors can be categorized as material-related, LCU-related and operator-related factors.

**CLINICAL SIGNIFICANCE:**

Proper light-curing techniques are critical for delivering an adequate amount of radiant exposure to RBCs. Adequate light curing decreases the number of underexposed RBC restorations, improves their mechanical and physical properties and accordingly, increases their clinical longevity.

**COMMENTS:**

The present literature review provides important information regarding the factors that influence radiant exposure in composite restorations in posterior teeth. Many factors can influence the irradiance, which can be the dependent materials such as photoinitiators, the thickness of the restorative material, the light transmission through the RBC, size / concentration of the charge particles, and the color (hue / chroma / translucency) of the resins. They can also be factors related to light curing devices, such as LED or halogens, radiant emission (mW / cm2), tip profile and device maintenance. The factors related to the operator are tip profile, distance and exposure time, and resin temperature.

In view of this, it is evident that there are many factors that negatively influence the radiant exposure, and with that they can reduce the success and longevity of the restorations, being they material and operator dependent. Correct photopolymerization techniques must be used according to the material to be used.

## FINAL CONSIDERATIONS

*The inefficient photopolymerization of resin composite materials is one of the biggest reasons for the clinical failure of these materials; therefore, the knowledge of information and instructions on the entire polymerization process is extremely important in the polymerization efficiency, achieving success and restorative longevity. One of the recurring information in the subjects previously addressed was the fact that light and light curing devices are not the same. It is not enough for the photoactivator to emit a visible blue light: this device must have adequate Irradiance, to meet the clinical challenges related to thickness and depth. Collimation of the efficient light beam;. Wavelength capable of being compatible with the different photoinitiators present in the various resin systems available and an adequate light output Tip, to obtain homogeneity in the light distribution, thus reaching the entire restoration body.*

Submitted: April 20, 2020

Revised and accepted: April 30, 2020

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