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Clinicians Report®
Serving Dentistry 43 YEARS
March 2019, Volume 12 Issue 3: Addendum 1
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ISSN 2380-0429

Are New Innovations in Curing LIghts More Effective?

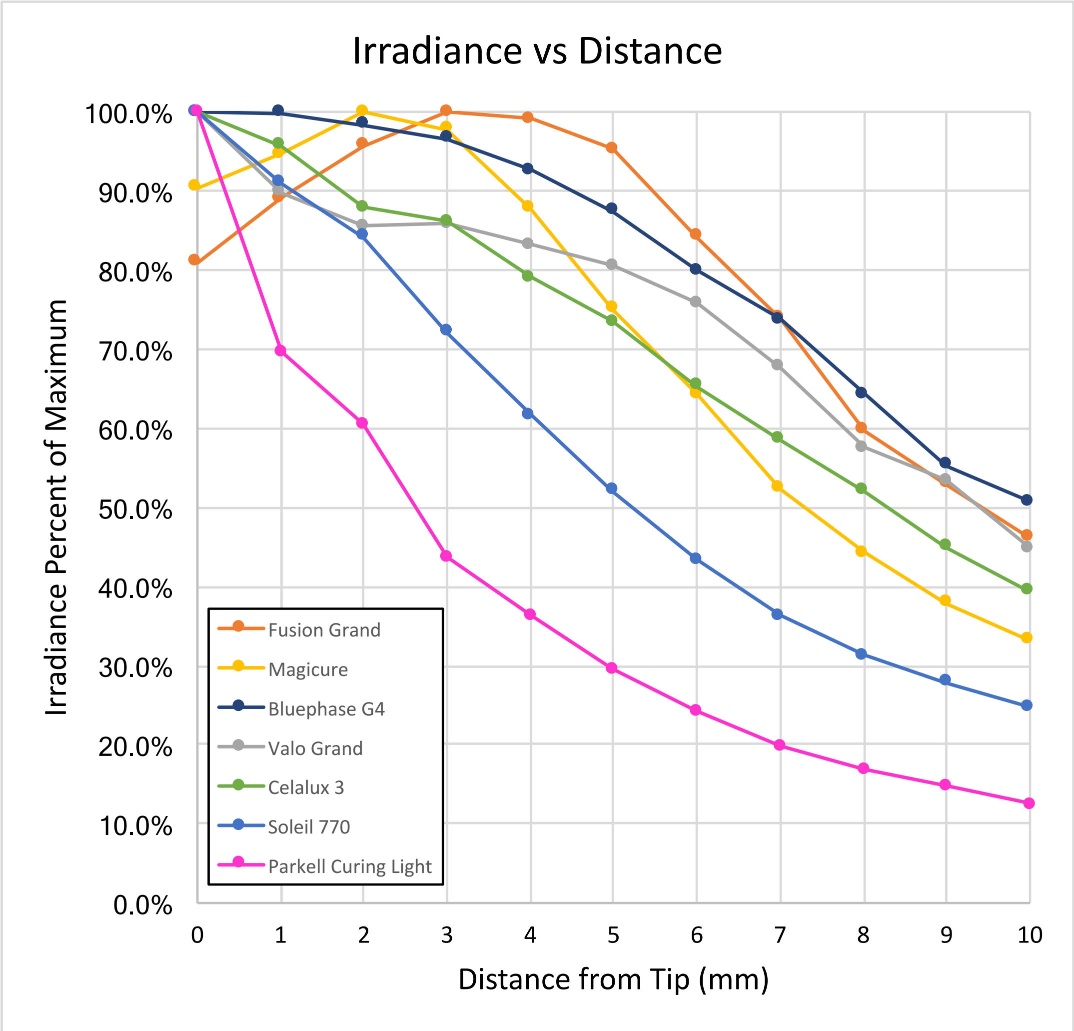
Curing Lights: Test Methods

- **Wavelength** *(spectral emission)* is measured with a spectrophotometer. CR currently uses the MARC RC system by BlueLight Analytics, or a stand-alone spectrophotometer by Ocean Optics.
- **Irradiance** *(power divided by surface area)* is measured with a calibrated radiometer using a diffuser or orifice of known dimensions. CR currently uses the MARC RC system, or an orifice on an integrating sphere and radiometer by International Light.
- **Total Power** is measured with an integrating sphere. CR currently uses a 25 cm sphere and radiometer by International Light.
- **Spot Profile** is analyzed as light passes through a diffuser, revealing the spatial distribution of energy. CR currently uses diffusers made of cured composite, with CCD camera capture and image analysis *(Image-Pro Plus, MediaCybernetics).*
- **Delivery System** and parameters of clinical use are evaluated by a team of experienced clinicians and scientists.

In addition, Dr. Richard Price *(Dalhousie University, Halifax, Nova Scotia, Canada)* graciously volunteered his time, expertise, and laboratory to also evaluate these curing lights. He provided much of the data included in the recent CR report, and his methods and equipment are considered among the most accurate and advanced in the profession.

Curing Lights: Additional Data

The following graph shows measured irradiance as the distance from the tip increases. To facilitate comparison, data have been normalized to a percentage of the maximum for each light. Lights that maintain higher irradiance over distance offer a clinical advantage as materials are often several millimeters beyond the actual tip of the light.



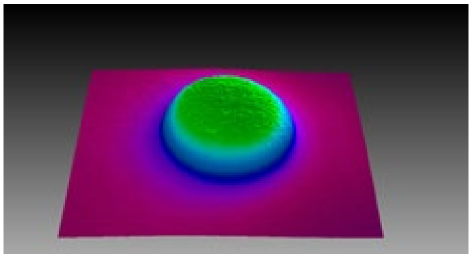
Curing Lights: Additional Data

The following images provided by Dr. Richard Price come from the beam profile test and represent the spatial distribution of energy for each light.

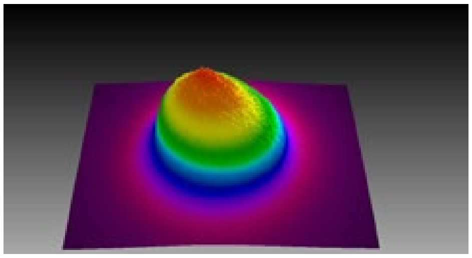
- For broad spectrum lights *(lights with more than one wavelength of LED)*, data were collected using two cutoff filters- 460nm and 400nm, to help visualize how the different wavelengths are distributed.
- The beam *(or spot)* is then shown as it diffuses through 0.5mm of composite resin, which usually causes some spreading of the energy.
- The final plot *(CR data)* shows the spot as it diffuses through 2mm of composite resin.

In all cases, an ideal beam, or spot, would appear as a cylinder, with nearly uniform irradiance across its surface and a sharp cutoff at the edge. The more misshapen the beam profile, the greater its non-uniformity of irradiation. The more cone-shaped the beam profile, the greater its loss of energy towards the edges of the spot. Again, a sign of non-uniformity.

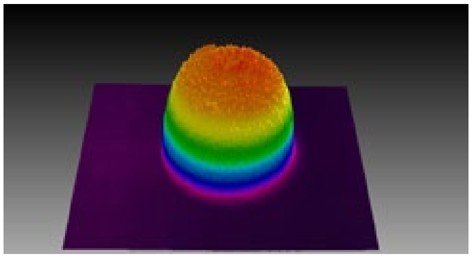
▶ Valo Grand *(Ultradent)* *(Study Control- broad spectrum, large tip)*



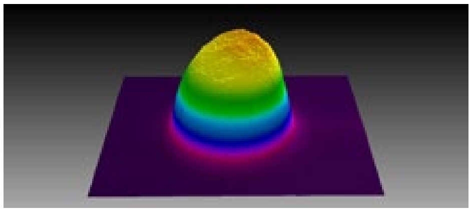
460nm filter



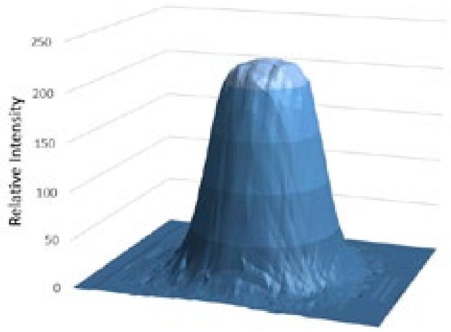
400nm filter



Total *(broad spectrum)*

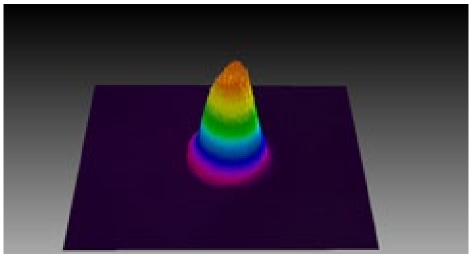


Through 0.5mm composite resin

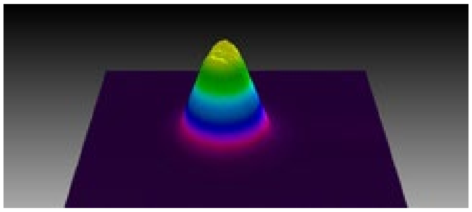


Through 2mm composite resin

▶ LED.B Woodpecker *(Study Control- narrow spectrum, small tip)*

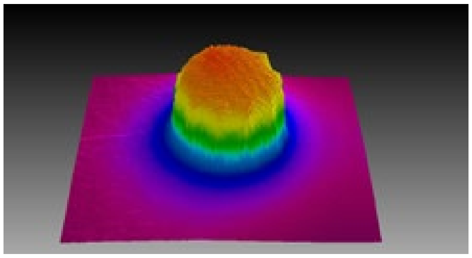


Total *(narrow spectrum)*

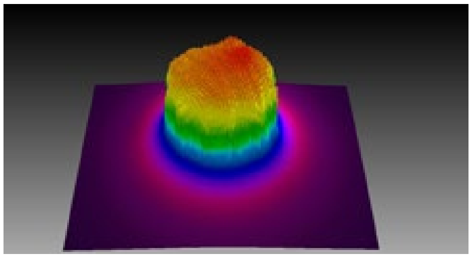


Through 0.5mm composite resin

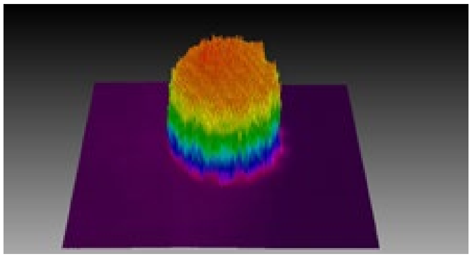
▶ Bluephase G4 *(Ivoclar Vivadent)*



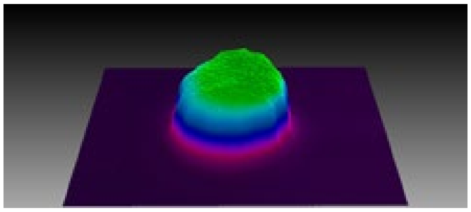
460nm filter



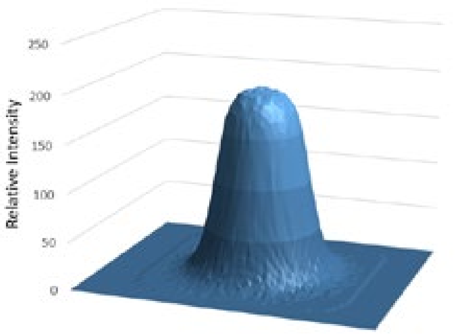
400nm filter



Total *(broad spectrum)*

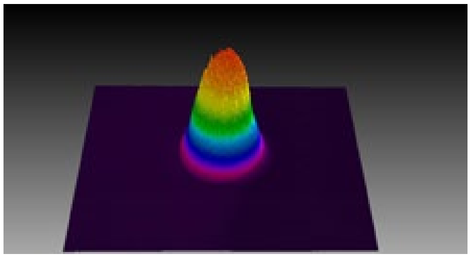


Through 0.5mm composite resin

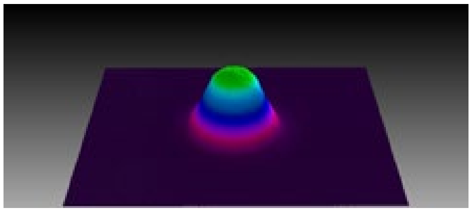


Through 2mm composite resin

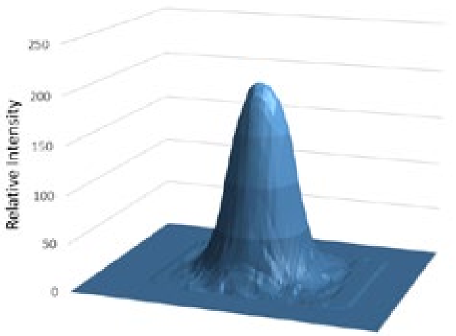
▶ Celalux 3 *(Voco)*



Total *(narrow spectrum)*

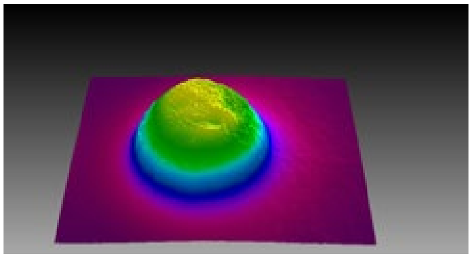


Through 0.5mm composite resin

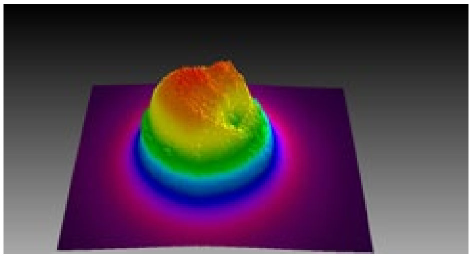


Through 2mm composite resin

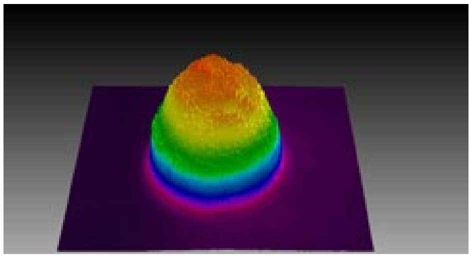
▶ Fusion Grand *(DentLight)*



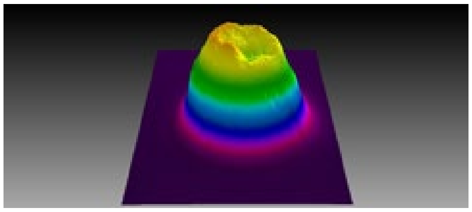
460nm filter



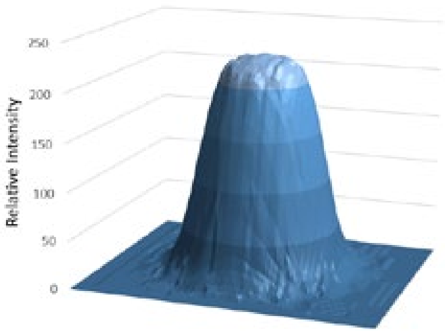
400nm filter



Total *(broad spectrum)*

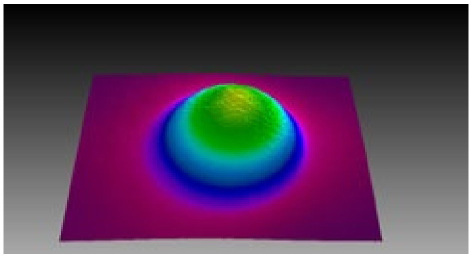


Through 0.5mm composite resin

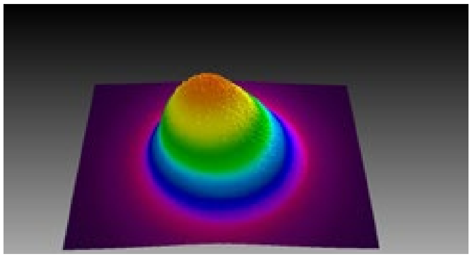


Through 2mm composite resin

▶ Magicure *(Strauss)*



460nm filter



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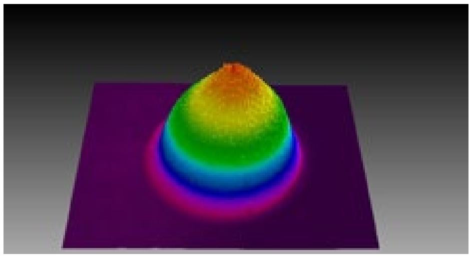
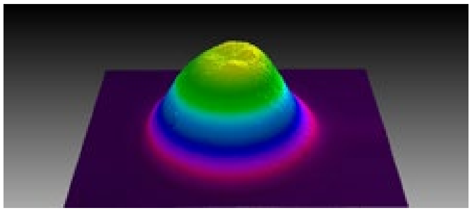
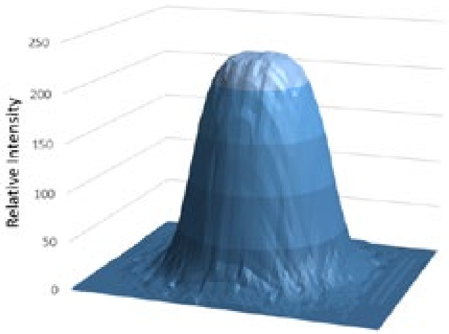


Total *(broad spectrum)*

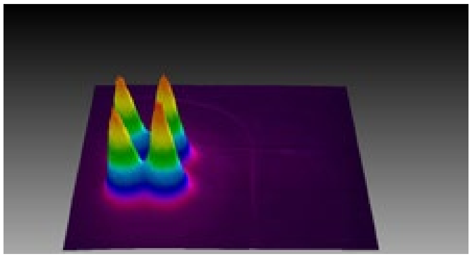


Through 0.5mm composite resin

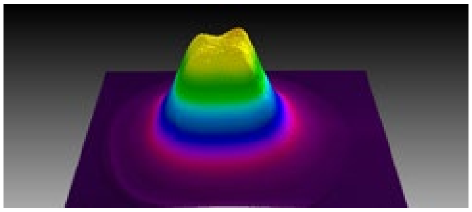


Through 2mm composite resin

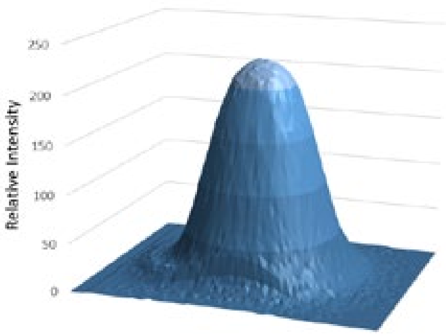
▶ Parkell Curing Light *(Parkell)*



Total *(narrow spectrum)*

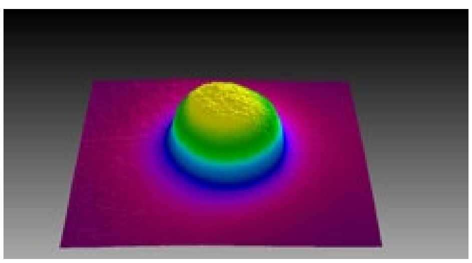


Through 0.5mm composite resin

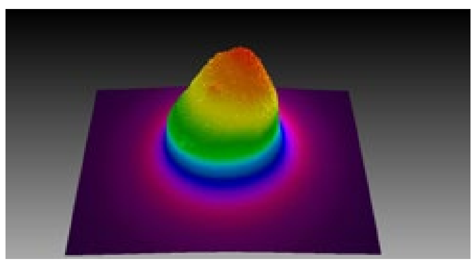


Through 2mm composite resin

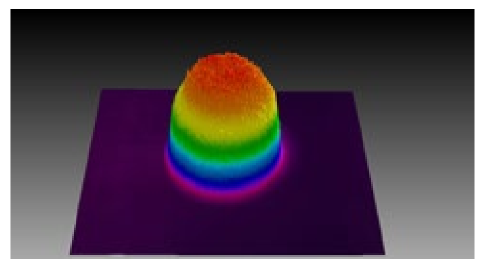
▶ Soleil 770 *(Benco)*



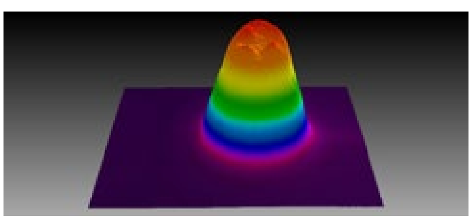
460nm filter



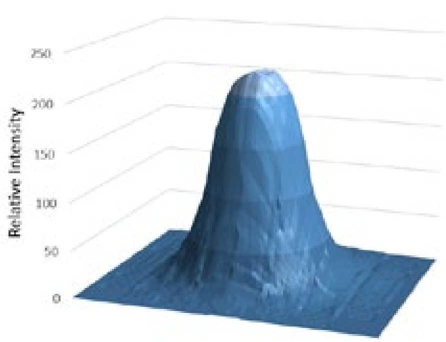
400nm filter



Total *(broad spectrum)*



Through 0.5mm composite resin



Through 2mm composite resin

Curing Lights: Some Key Considerations

- **Wavelength** of light emitted must match that needed by the resins' photoinitiators. Currently, there appears to be no compatibility problems: all blue lights effectively polymerize all light-cure materials. However, broad-spectrum emission is preferred because photoinitiators are sensitive across a broad range, beyond just the blue region. Broad-spectrum emission results in more effective and efficient photo-activation, and allows material manufacturers the ability to use advantageous combinations of different photoinitiators in their formulations.
- **Irradiance** is the power delivered over the surface of the material and has a significant influence on how quickly, completely, and how deeply the material polymerizes. In general, higher irradiance is preferred. However, too high of irradiance can cause significant heating of materials and oral tissues. Low irradiance or low total energy delivered to the material results in incomplete polymerization and poor material properties.
- **Delivery system** encompasses the design and use of the light, with its optics and controls. In general, features that make it easier to position, aim, and activate the light are preferred. Features that ensure adequate irradiance throughout the process are preferred. Features that simplify infection control and maintenance are preferred. However, there are trade-offs among features which result in myriad designs that appeal to different clinicians. For example, a light with a small tip can create high irradiance but at the cost of covering only a small area, thereby making it sensitive to alignment problems or requiring multiple activations to polymerize a large material area.
- **Material formulation** is a critical factor beyond the curing light used. Given adequate energy to initiate polymerization, the resin formulation itself plays a significant role in the polymerization kinetics and final material properties, such as degree of conversion, shrinkage, stress, hardness, polishability, wear, etc. CR research spanning four decades indicates that material formulation plays a greater role in clinical performance than the light used to initiate polymerization.