Lights, Curing

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Lights of a Different Nature (Originally published in May 2001)

Question: What is a light diode curing light? Are they better than plasma arc lights for curing composite?

Answer: Recently, several new types of lights have been marketed for curing resin composites and other light-activated materials. Only a couple of years ago, we saw the development of plasma arc curing lights (PAC lights), which are high-intensity light units. Their manufacturers claim they are better than traditional curing lights that use a halogen bulb as the light source because they can cure resin composite in as little as 1 to 5 seconds. PAC lights use a bulb that contains xenon gas and two probes. A voltage potential is created across the probes that ionizes the surrounding gas (plasma), which produces a spark and, in turn, white light. The light is filtered to allow only blue light to pass through the unit’s liquid tube. DIS has evaluated two PAC lights, the Apollo 95E (Diagnostic Medical Systems, see DIS 58-24) and the ARC Light II (Air Techniques, see DIS 61-25). While both units produced light with very high irradiance, neither cured resin composite as quickly as their manufacturers claimed. Also, they are considerably more expensive than halogen units, costing from 3 to 5 times as much. Both lights received a "Marginal" rating from DIS.

The latest development in light curing has been the marketing of units that use light-emitting diodes (LEDs) as their light source. The manufacturers of these units claim they have several advantages compared to halogen lights. First, unlike halogen lights, LED units produce light with a narrow spectral range. The diodes use gallium nitride as a semiconductor and produce light with a wavelength of from 450 to 490 nm and a peak at 460 nm. This is nearly ideal for activating materials that employ camphoroquinone as a photoactivator. The second advantage follows from the first: LED units require less power to operate since they only produce light of a narrow spectral range. As a result, they can be powered with rechargeable batteries. This makes it possible for them to be cordless, portable, and relatively lightweight. Another advantage is the extended life of LEDs. At most, halogen bulbs last a hundred hours or so, while LED can last thousands of hours. Also, unlike halogen bulbs and their filters and reflectors, LEDs do not degrade over time, so the light they produce is constant in intensity. Finally, LED lights produce less heat, so there is less potential for gingival and pulpal irritation.

Two caveats need to be kept in mind about LED lights, however. Since LED units produce light of a narrow bandwidth, materials using photoactivators with absorption spectra outside the LED range will not cure properly. Also, users and potential buyers should be aware that LED units produce light with lower irradiance values than halogen or PAC lights. This should not prevent them from adequately curing light-activated materials, as long as the proper spectral range of light is produced. However, this does complicate measuring their ability to cure resin composite since traditional radiometers can not be used to measure the adequacy of the output.

DIS has begun evaluating commercially-available LED units and will have reports and ratings available for them shortly. In the meantime, as with most products using a technology newly introduced to the dental field, it is probably wise to refrain from purchasing these units until we know how well they perform and how cost effective they are.

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"Soft-start" Polymerization of Resin-Composite Restorations (Updated Dec 2005)

**Question:** What can you tell me about "soft-start" polymerization?

**Answer:** "Soft-start" polymerization is a method recently advocated to reduce polymerization contraction stresses in resin-composite restorations. During early polymerization, the resin composite cross-linking network is relatively weak - allowing "flow" to fairly easily accommodate for stresses and prevent damage to adhesive bonds. With further polymerization, contraction and flow decrease, while stiffness and stress increase. This may cause adhesive failure. The bond strength must exceed the contraction stress to provide a stable marginal adaptation.1 "Soft-start" polymerization proposes that a slower rate of conversion will allow better flow of resin with a decrease in contraction stress. "Soft-start" polymerization may be divided into three separate techniques: stepped, ramped, or pulse-delay. A stepped program emits a low irradiance for 10 seconds and then increases immediately to a maximum value for the duration of the exposure. In a ramped program, the irradiance gradually increases from a low value to maximum intensity over a 10-second period, after which it remains constant for the duration of the exposure. Pulse delay uses a short low-level burst, a delay for polishing, and finally a long exposure at full intensity. The majority of laboratory research suggests that "soft-start" polymerization may be beneficial,2-17 but several studies have found no difference.18-23 Also, the limited clinical trials available have shown no significant difference between the "soft-start" technique and conventional cure.24,25 More *in vivo* research is desperately needed to substantiate the potential benefits of this concept.

**References**
16. Lim BS, Ferracane JL, Sakaguchi RL, Condon JR. Reduction of polymerization contraction stress for

Resin - LED Curing Light Incompatibilities (Originally published in September 2003)

**Question:** I tried to cure a bonding agent with my new LED curing light and it failed to polymerize? What happened?

**Answer:** Light-emitting diode (LED) curing lights have a narrow spectral emission of light and may not polymerize all dental resin materials. Conventional halogen lights have a much wider emission spectrum and do not have this problem. The typical LED curing light produces light in a very narrow wavelength with peaks around 440 to 470 nanometers (nm), depending on the brand. This is ideal for the most common photoinitiator, camphoroquinone (CQ), which has an absorption peak around 468 nm, but is less effective for other photoinitiators that have peaks below 440 nm, such as phenyl-propanedione (PPD). Camphoroquinone is yellow in color. New photoinitiators were developed to provide less yellow intensity, especially for translucent shades. Fortunately there are only a few resin products that use other photoinitiators. Clinical Research Associates (CRA) recently published a listing of products that may not polymerize adequately with many LED curing lights. Not all available resin materials were tested, but the products identified so far were Discover (Bisco, Schaumburg, IL); Cabrio (Discus Dental, Culver City, CA); Panavia F (Kuraray, New York, NY); Principle (Dentsply Caulk, Milford, DE); Pyramid, Neutral and Translucent (Bisco, Schaumburg, IL); and Touch and Bond (Parkell, Farmingdale, NY). Some companies have attempted to shift the emission spectrum of LED lights slightly to initiate multiple photoinitiators. However, a new LED light, Ultra-Lume LED 5 (Ultradent Products, South Jordan, UT), contains two different diodes with spectral-emission peaks near 400 and 450 nm. See DIS 68. This allowed the new LED curing light to cure all the problematic materials listed above.

The potential advantages of the new LED curing lights were outlined in a previous DIS newsletter. See DIS 62. Less power is necessary to operate LED curing units because of their unfiltered, narrow emission spectrum. Consequently they may be powered with rechargeable batteries, making them available in lightweight, cordless units. The diodes have a potential lifetime of several thousand hours instead of less than a hundred with halogen systems. Ninety-nine percent of the original energy emitted from a halogen light is useless energy that must be filtered out. Noisy fans are required to help eliminate this unwanted heat. LED units produce little wasted energy and require minimal cooling.

DIS is testing many new LED curing lights and the results will be continually reported. The first-generation LED lights suffered from low irradiance and high cost. See DIS 63, 64 and 66. The second generation of LED curing lights have much higher irradiance and competitive government pricing. See DIS 68 and
69. However, providers not using conventional halogen lights are advised to confirm the cure of their photo-initiated resin materials with their curing lights before they are used clinically.

References