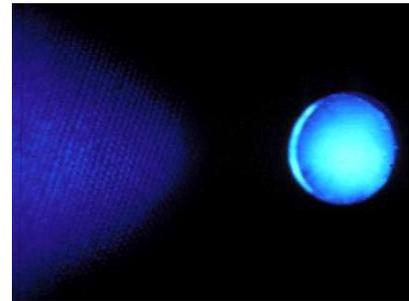


Synopsis of Light-Emitting Diode Curing Lights (Project 03-34) (5/04)

Light activation is the most common method of initiating the polymerization process in resin composites for use in restorative dentistry. Adhesive and resin composite systems have traditionally contained camphoroquinone (CQ), a visible-light-sensitive diketone photoinitiator responsible for initiating free-radical polymerization. CQ absorbs energy in the visible-light region of 400 to 500 nanometers with a peak at 468 nanometers. Photons associated with this frequency range will be absorbed by camphoroquinone, raising it from the ground state to an excited, activated state.^{1,2} After combining with an amine co-initiator, an aminoalkyl free radical is formed which initiates polymerization. Visible-light energy may be provided by four types of curing lights: quartz-tungsten-halogen (QTH), plasma-arc (PAC), argon laser, or light-emitting diode (LED).



The most common dental curing light in use today is the quartz-tungsten-halogen.³ The relatively broad emission spectrum of QTH curing lights allows them to initiate the polymerization of all composite resin materials available today. The principle output from these lamps is infrared energy with the generation of high heat. Filters are used to reduce heat dissipation to oral structures and to provide further restriction of visible light to the narrower spectrum of photoinitiators. The QTH curing lights are very inefficient and ultimately, 99.5% of the original radiation must be eliminated. With high operating temperatures, the QTH bulbs have a limited lifetime.^{4,5} DIS has evaluated many QTH curing lights over the past several years. They continue to provide a reliable and cost-effective method of photopolymerization.

Plasma-arc (PAC) lights generate a high-voltage pulse that creates hot plasma between two electrodes in a xenon-filled bulb.⁶ The irradiance (up to 2400 mW/cm²) is much higher than a typical QTH light, but the PAC lights generate very high heat with an inefficient emission spectrum similar to QTH curing lights. Filters limit the emission spectrum to the blue spectrum.⁴ DIS has reviewed several plasma-arc curing lights. Plasma-arc curing lights are expensive to purchase and maintain with replacement bulbs costing more than 10 times that of a typical QTH bulb. DIS testing found the reduced curing times claimed by manufacturers may be insufficient to cure all types of composites, especially microfills.

Light emitted from an argon laser is very different from that emitted from QTH or PAC lights. The photons produced are coherent and do not diverge, therefore they concentrate more photons of specific frequency into a tiny area.⁴ The emission spectrum is very narrow and compatibility problems with some photoinitiators would be anticipated. Argon lasers are extremely expensive and may not be cost-effective for the visible-light curing of resin materials in federal dental clinics.

LED curing lights were introduced to the dental profession in the fall of 2001 and use special semiconductors for the electroluminescence of light rather than a hot filament found in QTH lights.⁷ This provides a longer life span, consistent output and lower power consumption.⁸ Less power consumption allows the use of lightweight, hand-held, battery-powered units. No significant ultraviolet or infrared light is emitted thereby reducing lateral heat and minimizing the need for a noisy fan. DIS testing, however, has determined that the heat emitted from the tip of the light guide of LED curing lights is similar to halogen curing lights. Since the energy is clearly defined by the semiconductor, most of the light emitted is concentrated in a narrow band around 470 nanometers which is ideally suited for composite resins that use the photoinitiator camphoroquinone.⁹ However, the emission spectrums from LED curing lights are so narrow, they may not be absorbed by new photoinitiators. New photoinitiators were introduced by manufacturers in a few products to reduce the intensity of the yellow color of the composite resin restorative material typically produced with the addition of camphoroquinone or to prevent the inactivation of the amine co-initiator by acidic monomers contained in some enamel and dentin adhesives. These new photoinitiators (e.g., phenyl-propanedione, Lucirin TPO) absorb light energy in lower regions of the visible-light spectrum.¹⁰ The instruction booklet found with photo-initiated dental materials may not always indicate the type of photoinitiator contained in the dental material. Fortunately, very few resin

materials use the new photoinitiators. DIS surveyed dental product manufacturers (Project 03-23) and provided a list of the various photoinitiators found in many adhesive and composite formulations. A new LED curing light has been recently introduced (UltraLume 5, Ultradent Products) containing multi-spectrum LED lights that will cure all current photoinitiated dental materials.¹¹ However, providers not using broader spectrum curing lights, such as the QTH lights, should confirm the cure of their materials before clinical placement.

The first generation of LED curing lights had low power densities.¹² The lower power densities required longer curing times to deliver equivalent energy densities and depth of cure. The second generation of LED lights have much higher power densities and much higher depth of cure.¹³ DIS testing of the second generation of LED lights found irradiance, degree-of-cure, and government pricing similar to the most popular QTH lights. To make it easier for clinicians to compare and contrast various features of LED curing lights, information was obtained from manufacturers and compiled into tables. [Attachment 1](#) is a synopsis of the second generation LED curing lights currently on the market.

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Synopsis of LED Light-Curing Units* (5/04)

Curing Light	Advance LED 1	Allegro	Bluephase
Manufacturer	TPC Advanced Technology 17588 E. Rowland St. #286 City of Industry, CA 91748 (800) 560-8222 (626) 810-4337 www.tpcadvancedtechnology.com	Den-Mat Corporation 2727 Skyway Dr. Santa Maria, CA 93455 (800) 445-0345 (805) 922-8491 www.denmat.com	Ivoclar Vivadent 175 Pineview Dr Amherst, NY 14228 (800) 533-6825 (716) 691-2285 www.ivoclarvivadent.us.com
Price	Retail: \$850.00 Gov't: \$425.00	Retail: \$1295.00 Gov't: Same as retail	Retail: \$1350.00 Gov't: \$675.00
Accessories Standard with Light Purchase	Charging base Auxiliary power line Protective eye shield	Battery charger Protective eye shield 2 Protective glasses Hardness discs	Charging base Auxiliary power line Protective eye tip
Handpiece Weight & Dimensions	13.4 oz. 11.4" x 1.4"	12 oz. 11" x 2"	9.5 oz. 7.5" x 5.1"
Battery	Nickel-metal hydride Replacement price: Retail: \$109.00 Gov't: \$65.00	2 Lithium ion Replacement price: Retail: \$99.00 Gov't: Same as retail Low-battery indicator	Lithium ion Replacement price: Retail: \$125.00 Gov't: \$62.50
Handpiece Features	Continuous time with beep every 10 secs	Fan Digital display Adjustable, audible timer: 5, 10, 15, & 20 secs	Fan Digital display Adjustable, audible timer: 10, 20, 30, 40 & 120 secs Ramped and low-intensity curing modes
Light Guide/Aperture	8-mm dia. fiber optic	8-mm and 10x14-mm dia. solid acrylic	8-mm dia. fiber optic
Intensity Meter	Range-type	Digital	Range-type
Emission Spectrum	440 - 490 nm	425 - 485 nm	430 - 490 nm
Electrical Configurations	110V	100-200V	100-240V
Manufacturer Claimed Intensity [DIS Tested Value]	1,100 mW/cm ² [Not tested]	1400 mW/cm ² [8 mm: 1437 mW/cm ² 10x14 mm: 733 mW/cm ²]	1,100 mW/cm ² 1,250 mW/cm ²
Additional Light Guides Available	None	None	2-, 10-, & 13-mm dia. light guides
DIS Rating	Not evaluated	Rated Acceptable	Rated Excellent

Curing Light	BlueWand	FLASH-lite 1001	Freelight 2
Manufacturer	Kerber Applied Research 237B Highland Rd E. Stoney Creek, ON Canada (905) 664-3321 www.karcomm.net	Discus Dental 8550 Higuera St. Culver City, CA 90232 (800) 422-9448 (310) 845-8260 www.discusdental.com	3M Dental Products Division 3M Center, Bldg 275-2SE St. Paul, MN 55144-1000 (800) 237-1650 (612) 733-8524 www.3MESPE.com
Price	Retail: \$1095.00 Gov't: Call company	Retail: \$695.00 Gov't: \$545.00	Retail: \$1350.00 Gov't: \$810.00
Accessories Standard with Light Purchase	Charging base	Charging base Protective eye tip Hardness discs Lens caps	Charging base Protective eye shield
Handpiece Weight & Dimensions	5.3 oz. 8.5" x 0.5"	3.8 oz. 8" x 0.88"	8 oz. 11.2" x 1.2"
Battery	Nickel-Metal Hydride Replacement battery: Return to company	Lithium ion Replacement battery: Return to company	Nickel-metal hydride Replacement price: Retail: \$110.00 Gov't: Same as retail Low-battery indicator
Handpiece Features	Adjustable, audible timer: 10, 20, & 30 secs with beeps every 5 secs	Continuous time with beep every 5 secs	Adjustable audible & LED timer: 5, 10, 15, & 20 secs
Light Guide/Aperture	Built-in 5x5-mm aperture	Built-in 7.5-mm dia. aperture	8-mm dia. fiber optic
Intensity Meter	None	Range-type	Range type
Emission Spectrum	440 - 480 nm	445 - 495 nm	430 - 480 nm
Electrical Configurations	100-240V	90-240V	120V
Manufacturer Claimed Intensity [DIS Tested Value]	1500 mW/cm ² [Not tested]	1001 mW/cm ² [969 mW/cm ²]	1000 mW/cm ² [Not tested]
Additional Light Guides Available	None (built-in)	None (built-in)	13-mm dia. light guide
DIS Rating	Not evaluated	Rated Acceptable	Not evaluated

Curing Light	Hilux LED 3	LEDemetron 1	Radii
Manufacturer	First Medica 3704-C Boren Dr. Greensboro, NC 27407 (800) 777-7072 (336) 292-8877 www.firstmedica.com	SDS/Kerr 21 Commerce Dr. Danbury, CT 06810-4153 (800) 537-7123 (203) 748-0030 www.kerrdental.com	Southern Dental Industries 729 N.Route 83, Suite 315 Bensenville, IL 60106 (800) 228-5166 (630) 238-8300 www.sdi.com.au
Price	Retail: \$949.00 Gov't: \$595.00	Retail: \$1200.00 Gov't: \$750.00	Retail: \$695.00 Gov't: Same as retail
Accessories Standard with Light Purchase	Charging base Protective eye tip and shield	Battery charger Protective eye shield Handpiece stand Hardness discs	Charging base Protective eye tip and shield Lens caps
Handpiece Weight & Dimensions	16 oz. 7" x 5"	12.9 oz. 10.5" x 1.9"	5.4 oz. 9.6" x 1"
Battery	Nickel-metal hydride (standard AA)	2 Nickel-metal hydride Replacement price: Retail: \$75.00 Gov't: \$45.00 Low battery indicator	Lithium ion Replacement price: Not provided
Handpiece Features	Fan Digital display Adjustable, audible timer: 2 - 90 secs Fast-, standard-, or ramp-curing modes	Fan Digital display Adjustable, audible timer: 10, 20, & 40 secs	Continuous time with beep every ten secs Ramped-curing mode
Light Guide/Aperture	11-mm dia. fiber optic	10-mm dia. fiber optic	Built-in 8-mm dia. aperture
Intensity Meter	None	Range type	Range type
Emission Spectrum	440 - 490 nm	430 - 480 nm	440 - 480 nm
Electrical Configurations	110V	100-240V	90-264V
Manufacturer Claimed Intensity [DIS Tested Value]	800 - 1000 mW/cm ² [Not tested]	483 mW/cm ² [600 mW/cm ²]	1400 mW/cm ² [Not tested]
Additional Light Guides Available	None	Multiple (interchangeable with Demetron halogen)	None (built-in)
DIS Rating	Not evaluated	Rated Recommended	Not evaluated

Curing Light	SmartLite iQ	The Cure	UltraLume LED 5
Manufacturer	Dentsply Caulk 38 West Clark Ave Milford, DE 19963 (800) 532-2855 (302) 422-4511 www.dentsply.com	Spring Health Products 705 Gen. Washington Ave Norristown, PA 19403 (800) 800-1680 (610) 630-9171 www.springhealthproducts.com	Ultradent Products 505 West 10200 South South Jordan UT 84095 (800) 496-8337 www.ultradent.com
Price	Retail: \$1100.00 Gov't: \$803.00	Retail: \$499.00 Gov't: \$450.00	Retail: \$999.00 Gov't: \$849.15
Accessories Standard with Light Purchase	Charging base Protective eye shield	Handpiece holder 2 protective eye tips Disposable barrier sleeves	5 Curing lenses 1 "Point Cure" lens 1 "ProxiCure" lens 2 "TransLume" lenses Surface handpiece holder Disposable barrier sleeves
Handpiece Weight & Dimensions	8 oz. 6.6" x 1.4"	1 oz. 6" x 0.75"	11 oz. 7.5" x 0.63"
Battery	Lithium ion Replacement price: Retail: \$89.95 Gov't: \$58.79 Low-battery indicator	None (corded)	None (corded)
Handpiece Features	Digital display Adjustable, audible timer: 10, 15, 20, 30, & 40 secs Continuous up to 60 secs	Continuous time (up to 16 secs) with beep every two secs. High-, low-, or step-curing modes	Adjustable, audible timer: Curing - 10, 20, 30, 40 secs Tacking - 1, 2, 3, 4 secs
Light Guide/Aperture	8.5-mm dia. fiber optic	Built-in 8-mm aperture	Built-in 10x14-mm aperture
Intensity Meter	Range type	None	None
Emission Spectrum	430 - 495 nm	435 - 505 nm	380 - 480 nm
Electrical Configurations	100-240V	100-240V	100-240V
Manufacturer Claimed Intensity [DIS Tested Value]	None provided [500 mW/cm ²]	500 or 1000 mW/cm ² [Not tested]	> 800 mW/cm ² [> 593 mW/cm ²]
Additional Light Guides Available	None	None (built-in)	None
DIS Rating	Rated Recommended	Not evaluated	Rated Acceptable

*The manufacturers provided information in these tables

