Cure depths using different light units

By: Howard E. Strassler, DMD
Consultant to Den-Mat

Light-cured materials are widely used in today's dental practice. The chemical photoinitiators for these materials may be either camphorquinone (CQ) or a proprietary reagent sensitive to light in the blue wavelength range of 400-500nm. It has been reported that the minimum curing intensity of 400mW/cm² at the wavelength of 468± nm of blue light is necessary to assure complete polymerization of composite resin. Depth of cure is a function of light intensity, time, wavelength of light, type of composite resin, temperature of composite resin, distance between light and resin, shade of composite resin, if tooth structure overlies the composite resin, amount of light activated accelerator and heat generated from light curing units.

In recent years, light curing units with higher intensities than traditionally used lights have been introduced. These units generate higher intensity blue wavelength light either through the use of higher wattage quartz halogen light bulbs, increasing the concentration of fiber-optic bundles at the light curing tip when compared to the initial collection of light of the light guide (turbo tips), or using a high-intensity light generator in the form of a xenon plasma arc chamber. Lasers have also been used for light curing. Most recently, light curing units using light emitting diodes in the blue wavelength range have been introduced. Many questions have been raised about fast, high-intensity light curing versus ramped or soft polymerization light curing. Researchers have investigated resin polymerization stresses and potential damage to enamel. While these stresses can be measured and are seen as enamel fracture in the laboratory, the clinical significance of these stresses is not yet demonstrated. What is known is that different light curing units photopolymerize composite resins at different depths of cure during equal time increments due to varied light intensities. The higher intensity light curing units recommend less curing time to achieve equivalent depths of cure compared to traditional quartz halogen units. Do high-intensity light curing units require less time for photopolymerization? When light intensity is measured it has been found that from increasing intensity to decreasing intensity lights can be classified:

PAC light > HiQHL > QHL > LED	
PAC	xenon plasma arc greater than 1300mW/cm²
HiQHL	high quartz halogen 1000-1200mW/cm²
QHL	conventional quartz halogen 400-800mW/cm²
LED	light emitting diode 250-350mW/cm²

The purpose of this study was to compare the light curing depths of four different types of curing lights using three different classifications of composite resin.

Fig. 1

Fig. 2

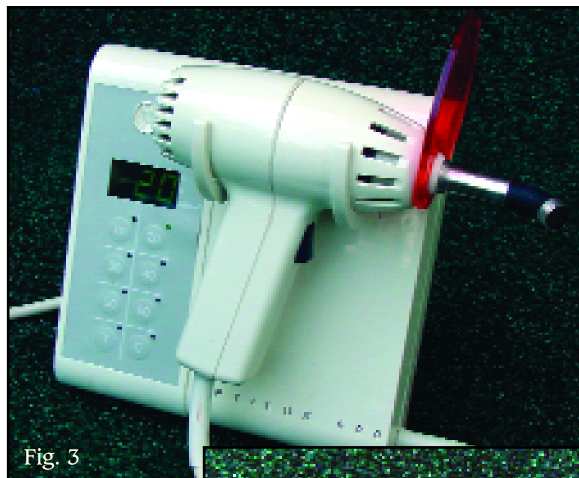

Fig. 3

Fig. 4

Methods and materials

Four different types of light curing units were selected. They were Den-Mat's Rembrandt Sapphire Light (Plasma arc light- PAC) (Fig. 1), Den-Mat's Virtuoso Phase II (high quartz halogen light-HiQHL) (Fig. 2), Kerr-Demetron's Optilux 500 (quartz halogen light- QHL) (Fig. 3) and Centrix's Versalux (light emitting diode-LED) (Fig. 4). The diameter for the light guides for each light were as follows:

Rembrandt Sapphire Light (Den-Mat)= 9mm
Virtuoso Phase II (Den-Mat) = 7.5mm
Optilux 500 (Kerr) = 9mm
Versalux (Centrix) = 8mm

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Two different brands of three different composite resin types were selected. All composite resins evaluated were shade A2. The composite resins tested were:

Hybrid composite resin	Prisma TPH (Dentsply/Caulk) Z-250 (3M)
Flowable composite resin	Revolution (Kerr) Virtuoso Flowable (Den-Mat)
Microfill	Durafill (Hereaus-Kulzer) Virtuoso Sculptable (Den-Mat)

The composite resins were placed into a 7mm high Teflon mold with a centered hollow area that had a diameter of 4mm. To assure complete polymerization and elimination of the oxygen inhibited layer on the light tip side of the specimen, a mylar strip was placed between the composite resin and light tip (Fig. 5). The Teflon mold was placed on a glass slab when the composite resin was placed into the mold. The composite samples were light cured at different curing times as recommended by the manufacturer.

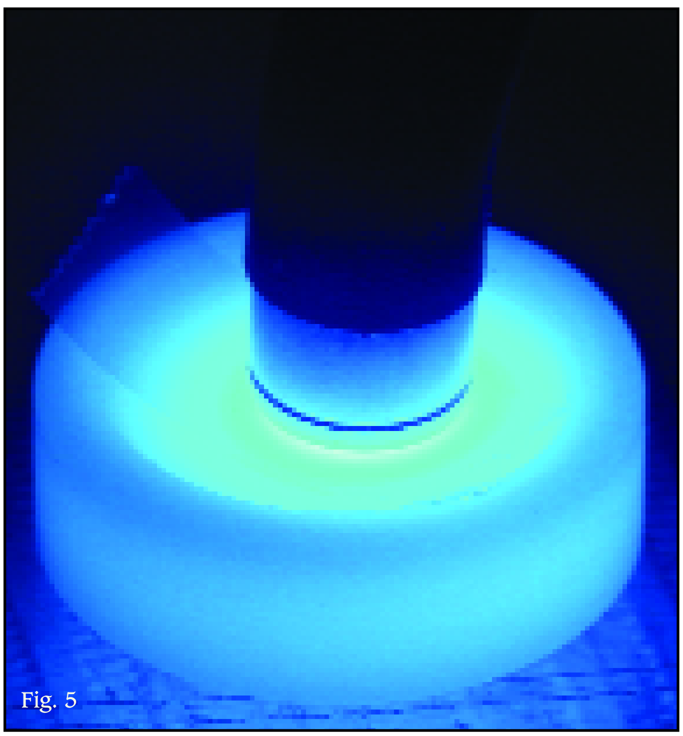

Fig. 5

Five specimens were made for each composite resin with each curing light. The specimen was removed from the mold. Depth of cure was measured by using a sharp explorer penetration test. Resistance to penetration was noted as cured. Penetration of the explorer tip was uncured. The depth of cure was then measured using a digital micrometer (Mitutoyo Digimatic). The results are listed in Table 1.

Conclusions

1. The Rembrandt Sapphire Light (Den-Mat) gave the deepest depth of cure combined with the shortest time for curing (3 seconds).
2. Results indicate that there is variation in depth of cure dependent on light type and composite type.
3. The hybrid composite resins had the deepest depth of cures with all lights tested.
4. Clinicians should check the depth of cure of different composite resins to make a determination for optimal cure with the light-curing unit they are using.
5. In general, Rembrandt Sapphire PAC light cures several times faster than halogen and LED lights.

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Howard E. Strassler, DMD, is a Professor and Director of Restorative Dentistry at the University of Maryland Dental School. He can be contacted at 666 West Baltimore Street, Baltimore, Maryland 21201. Email: hes001@dental.umaryland.edu. Dr. Strassler has performed funded research in the past for Den-Mat and is a consultant to Den-Mat.

Depth of Cure (Table 1)

Light (light guide diameter)		Cure time (sec)	Z-250	TPH	DF	VS	Rev	VF
PAC	9 mm (Rembrandt Sapphire)	3	7.0mm	7.0mm	4.8mm	5.5mm	4.8mm	5.9mm
HiQHL	7.5mm (Virtuoso II)	5	6.8mm	6.9mm	5.2mm	5.6mm	4.6mm	5.8mm
QHL	9 mm (Optilux 500)	10	6.8mm	6.9mm	5.6mm	5.7mm	6.5 mm	6.6 mm
LED	8 mm (Versalux)	20	6.5mm	6.4mm	3.7mm	5.1mm	4.3mm	4.9 mm