Light Curing in Dentistry

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KEYWORDS

- Curing lights • Composite resin • Polymerization • Blue light hazard
- Dental curing lights

KEY POINTS

- The ability to light cure resins 'on demand' in the mouth has revolutionized dentistry.
- However, there is a widespread lack of understanding of what is required for successful light curing in the mouth.
- This article provides a brief description of light curing, resin photopolymerization, types of curing lights, interplay between light tip area and irradiance, and how to monitor light output.
- Recommendations are made to assist when selecting a curing light and guidelines are given to improve light curing technique.

The ability to light cure dental resins "on demand" in the mouth has revolutionized modern dentistry. Consequently the dental light curing unit (LCU) has become an indispensable piece of equipment in almost every dental office.[1–3] As a general recommendation, when light curing a dental resin, adhesive, sealant, or cement the clinician should aim to deliver sufficient radiant exposure at the correct wavelengths of light required by the photoinitiator(s) in the resin. It is not as just simple as using any curing light for 10 seconds, despite its routine use, the curing light and how it is should be used is not well understood by most operators.[4–6] For example, every published study that has evaluated LCUs in dental offices has shown that most curing lights are poorly maintained and deliver an inadequate light output.[7–13] In the majority of offices, the dentists did not know the irradiance from the curing light[6] and were unaware that their light was unable to adequately cure their resin restoration.[12] This deficiency is a concern because the use of resins is expected to rise with the worldwide phase-down in the use of dental amalgam as a part of the Minamata Convention.[14] It is also reported that "tooth-colored materials are inferior to amalgam as fillings, especially for posterior teeth; and that, compared to amalgam, resin composites are far more technique sensitive, have lower clinical survival rates, are more expensive, and are far more difficult to adapt to proper tooth contour.[14]" A contributing factor

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to some of the problems associated with tooth colored resins may be because they have been undercured. This situation is highly undesirable; undercuring results in decreased bond strengths to the tooth, more bulk fractures of the resin restoration, increased wear, and an increase in the amount of leached chemicals from the resin.[15–19] This article discusses the current knowledge of dental curing lights and their use in dentistry.

RADIOMETRIC TERMINOLOGY

The International System of Units (SI) terminology should be used to describe the output from a dental LCU. Commonly used terms in dentistry to describe the output from a curing light such as "intensity," "power density," or "energy density" are not SI terms and they should not be used because they can lead to confusion. The appropriate SI radiometric terms to describe the output from a curing light are provided in Table 1.[3,20] In keeping with the output range from LCUs, these output values are usually reported in milli-Watts (mW) rather than Watts.

HEALTH AND SAFETY ISSUES

Electromagnetic Risk from Curing Lights

There has been some concern that electromagnetic (EM) emissions from external electrical devices such as LCUs can mimic or obscure intracardiac signals and potentially disrupt the function of implanted cardiac pacemakers.[21] However, when tested in a 2015 study, the dental curing light did not seem to interfere with pacemaker and or

Table 1
Radiometric terminology used to describe the output from a light source

Term	Units	Symbol	Notes
Radiant power, or radiant flux	Watt	W	Radiant energy per unit time (joules per second).
Radiant exitance, or radiant emittance	Watt per square centimeter	W/cm^2	Radiant power (flux) emitted from a surface, for example, the tip of a curing light. This is an averaged value over the tip area.
Irradiance (incident irradiance)	Watt per square centimeter	W/cm^2	Radiant power (flux) incident on a surface of known surface area. This is an averaged value over the surface area.
Radiant energy	Joule	J	This describes the energy from the source (Watts per second).
Radiant exposure	Joule per square centimeter	J/cm^2	This describes the energy received per unit area. Sometimes this is incorrectly described as "energy density."
Radiant energy density	Joule per cubic centimeter	J/cm^3	This is the volumetric (cm^3) energy density.
Spectral radiant power	Milli-Watt per nanometer	mW/nm	Radiant power at each wavelength (nm) of the electromagnetic spectrum.
Spectral irradiance	Milli-Watt per square centimeter per nanometer	$mW/cm^2/nm$	Irradiance received at each wavelength (nm) of the electromagnetic spectrum.