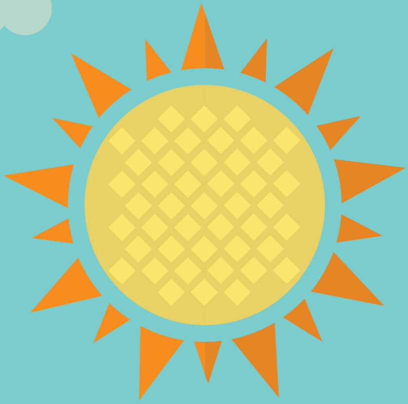


The Fundamentals of Light Curing Technology

Key concepts to know for a successful light-curing process using solvent-free materials.

SPECTRAL OUTPUT

Spectral output is the radiant output of a lamp vs. wavelength – commonly charted out as output watts plotted against wavelength.

Facts:

1.

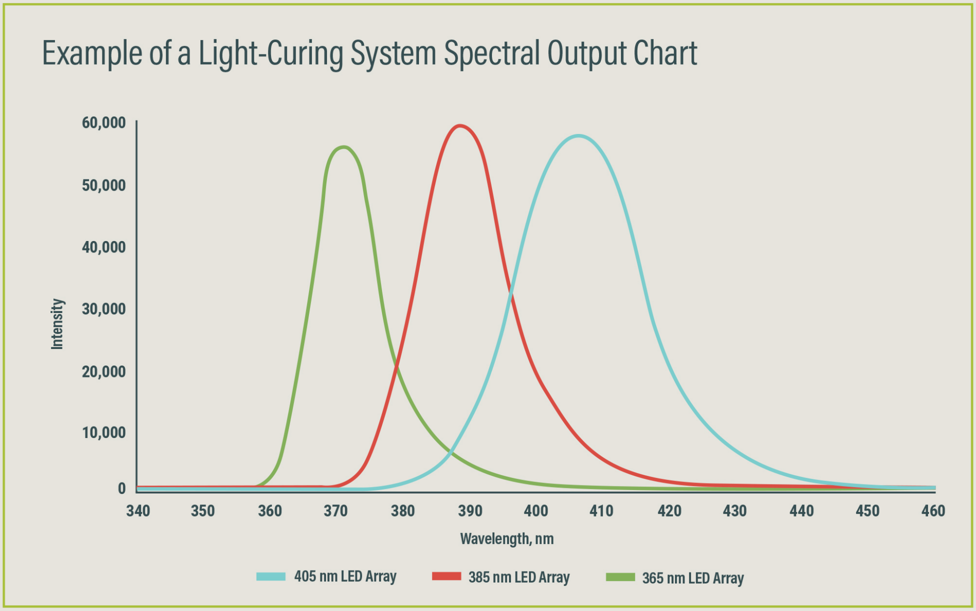
CURING BULBS VARY IN THEIR SPECTRAL OUTPUT

2. COMMON SPECTRAL OUTPUTS: 365nm, 385nm, & 405nm

3. THE SPECTRAL OUTPUT OF A CURING SYSTEM IS SOMETIMES MODIFIED BY FILTERS

4. OUTPUT OF A CURING LAMP MUST BE MATCHED TO THE ABSORPTION OF THE PHOTOINITIATOR IN THE LIGHT CURABLE MATERIAL (LCM)

5. IMPROPER MATCH = FAILED BOND


Example of a Light-Curing System Spectral Output Chart

INTENSITY

Intensity is the light energy reaching a surface per time – often measured in milliwatts per time. Or, more specifically, milliwatts per centimeter squared (mW/cm2). The long and short of it:

Facts:

1. INTENSITY VARIES BY

WAVELENGTH

2. THE HIGHER THE INTENSITY, THE FASTER THE CURE ↑

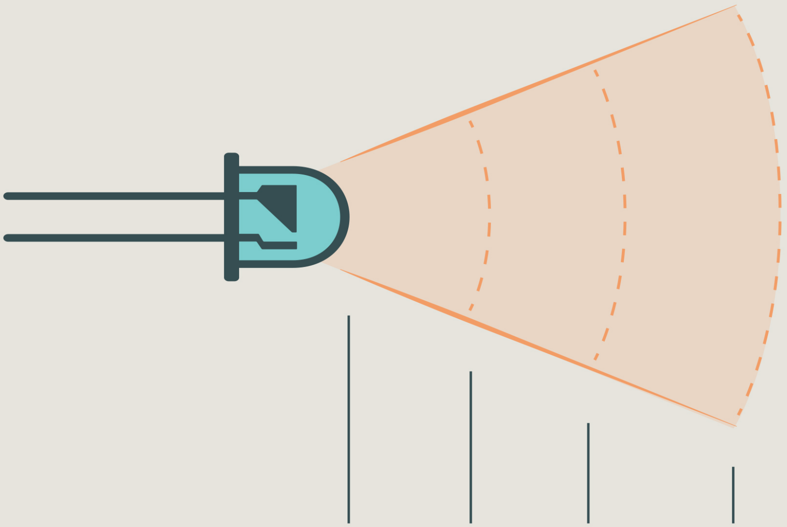
3. INTENSITY IS ALWAYS AFFECTED BY THE DISTANCE FROM THE LIGHT-CURING LAMP TO THE SURFACE

4. FOR FOCUSED BEAM SYSTEMS, AS DISTANCE FROM THE FOCAL POINT INCREASES,

●- - - - - - - - - - - - →

INTENSITY DECREASES

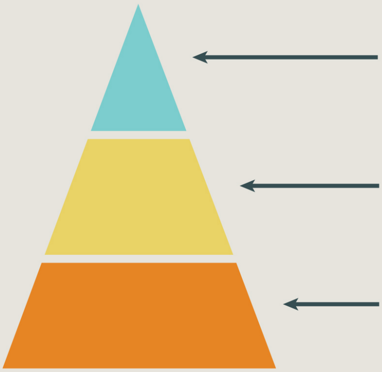
THE EFFECT OF DISTANCE ON INTENSITY



Distance from a Light Source	0” / 0mm	0.5” / 0mm	1” /25mm	1.5” / 38mm
Relative Intensity	100%	18%	6%	3%

THE COMPOSITION OF LIGHT-CURABLE MATERIALS

Light-curable materials (LCMs) are typically composed of four main ingredients, which are tailored to suit specific applications. Those ingredients include:.



Photoinitiators - chemicals that fragment into free radicals when exposed to light.

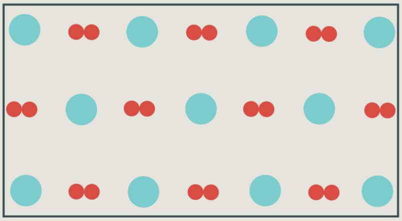
Additives / Modifiers - added to fine-tune formulations and provide unique features such as fluorescing or color.

Monomers - give formulations their specific properties.

Oligomers - medium-length polymer chains that give the formulation its basic properties (i.e. elongations, shrinkage, hardness, etc.).

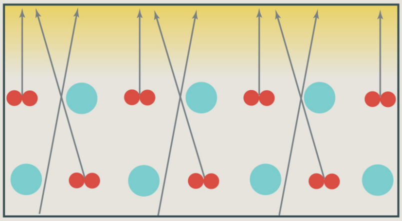
THE POLYMERIZATION PROCESS

There are four parts to the Polymerization Process:



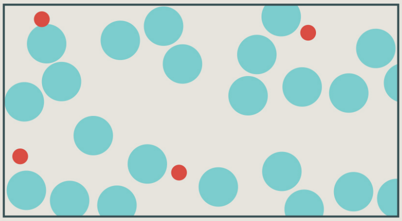
1. Liquid Unreacted State

Light curable materials (LCM) begin in this state before the curing process. They use energy provided by ultraviolet (UV) or visible light to start a curing reaction. When the photoinitiator in an LCM is exposed to a light-energy source of the correct spectral output, the curing process begins.



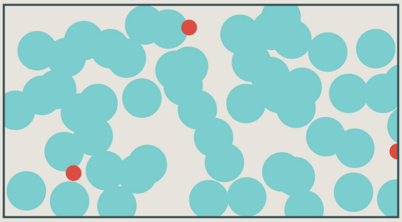
2. Photointiators Generate Free Radicals

LCMs utilize photoinitiators that are sensitive to different ranges of light. This makes it important to match the material being cured with the proper light source to cure it. Most LCMs used for assembly and thick-layer curing – from 0.0003”-0.25” (.05mm-6+mm) – use a broad spectrum of UV light with a concentration in the UVA range to achieve cure. Some materials also use visible (blue) light for cure. Once light is introduced, it excites and fragments the photoinitiators, resulting in the generation of free radicals.



3. Polymer Propagation

The free radicals begin to attach themselves to the acrylates that make up the LCM, resulting in polymeric chain radicals.



4. Polymer Termination

This process is repeated until all free radicals are attached, resulting in polymer termination, and the material is cured.

DYMAX®

Dymax manufacturers curing equipment and compatible adhesives, coatings and resins. We focus on creating solvent-free materials that cure clean, green, and fast, helping engineering teams accomplish more in less time and with less negative impact on the environment.

www.dymax.com