LAMPS FOR CURING UV ADHESIVES

ADVANCED TECHNOLOGY FOR RESEARCH & INDUSTRY

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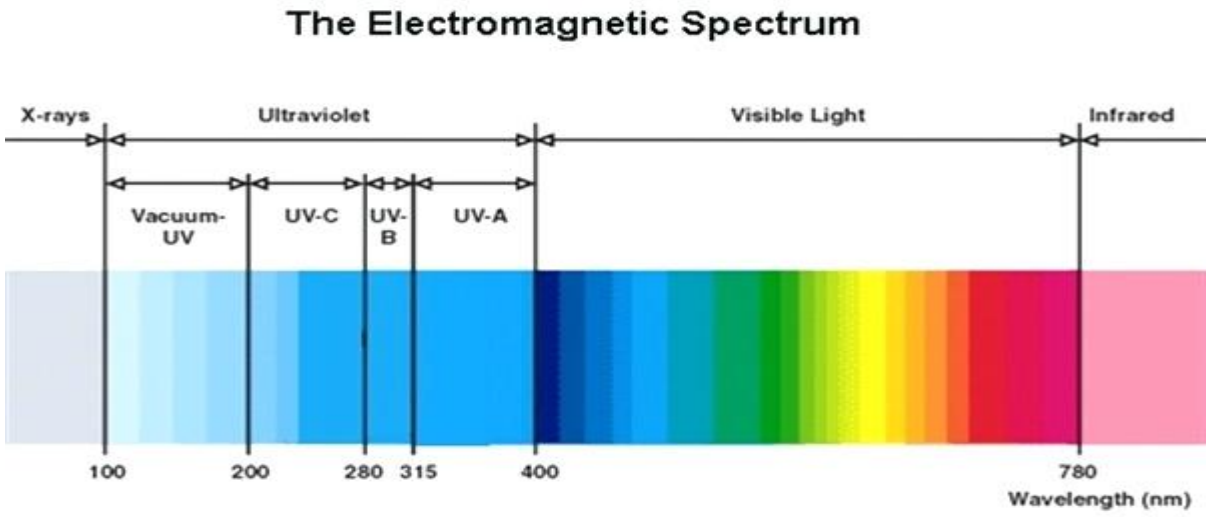
- SCOPE: An overview of the different technologies involved in curing UV adhesives

Historically, wide-spectrum lamps have been used to cure UV adhesives, but with advances in LED technology, using lamps containing Light Emitting Diodes has become more popular over the last few years due to their lower cost-of-ownership.

The term “UV adhesive” is used to denote any adhesive that needs light to cure, and is factually misleading because it refers to adhesives that cure in the Ultra-Violet part of the spectrum AND adhesives that cure in the visible light (VIS) part. The generally-accepted definition of a pure UV adhesive is one that cures between 100 and 400nm, while VIS adhesives cure between 400 and 780nm. The UV spectrum can be broken down further into Vacuum UV (100 - 200nm), UV-C (200 - 280nm), UV-B (280 - 315nm) and UV-A (315 - 400nm). Wide-spectrum UV lamps should contain a filter at the lamp output to remove all of these except UV-A, operating in a similar manner to the ozone layer above the Earth that filters out these same UV wavelengths.



Wide-Spectrum Lamps

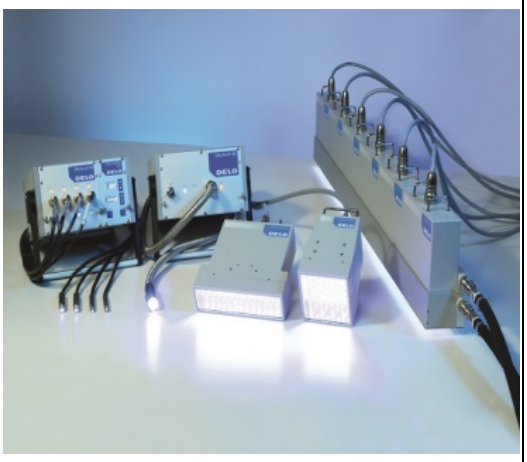
These will usually emit light between 200nm & 550nm and so are suitable for curing almost all light-cured adhesives on the market. Mercury bulbs, or derivatives thereof, are used in these lamps because they are relatively straightforward to manufacture. As stated above, the bulb works over a wide wavelength spectrum, relying on a filter in the glass casing to remove the harmful aspects of UV light. When setting up a manufacturing process with a wide-spectrum lamp, factors that need to be considered are: a) the time it takes for the bulb to reach operating strength after switching it on (~ 5 minutes); b) frequent monitoring of the intensity of the light, as new bulbs go through a burn-in process when first installed, meaning that after around 50 hours, the intensity will drop by ~ 20% to its regular operating strength; c) because the bulbs take 15 - 20 minutes to cool down after switching the lamp off, it cannot be switched on again during this period because the mercury in the bulb needs to condense, so switching a lamp back on before this can happen will cause the bulb to crack; and d) the operating lifetime of the bulb is in the region of 1,000 hours (depending on the lamp), after which the intensity drops off considerably and the bulb will need to be replaced.

Wide-spectrum lamps emit ~ 30% UVA light, 10% VIS light, and 40% infra-red light. A consequence of this is that for some adhesives such as light-activated epoxies, it can be an added advantage because these adhesives cure exothermally, and the additional heat generated by the bulb can reduce the cure time. But because these lamps do produce heat, care needs to be taken to ensure that the bulb is properly ventilated. Also, some temperature-sensitive substrates cannot be used with these lamps - they could distort and maybe even give off smoke. Mercury bulb lamps also emit the light in a wide arc from the exit area of the lamp, so some sort of shielding needs to be placed around the workspace to protect operators and any casual passers-by. Coloured Polycarbonate is usually used for this purpose, as most grades of Polycarbonate act as UV blockers.

LED Lamps

Unlike wide-spectrum lamps, LED lamps operate at very specific wavelengths, namely 365nm, 400nm or 460nm. 365nm LED lamps will cure adhesives that only contain a UV photoinitiator; 460nm LED lamps cure adhesives that only have a VIS photoinitiator, while 400nm LED lamps straddle the border between the two and will cure most adhesives that contain either photoinitiator. For this reason, 400nm LED lamps are the most popular of the three wavelengths, because they will cure most light-cured adhesives on the market. In addition, 365nm LEDs tend to be more expensive than the others, making the lamps more expensive, sometimes by a substantial amount. It can also make it easier to switch between adhesives, without investing in a new lamp, given that most adhesives can be cured with 400nm lamps.

The other significant difference from wide-spectrum lamps is that, because the heat is removed from the LEDs by either active or passive cooling, these lamps are cold lamps. So there is no cooling-down period when LED lamps are switched off, which results in curing-on-demand for the system – the lamp is only “on” when light is required. Therefore, while a wide-spectrum lamp is switched on for the duration of the production period, say 8 hours a day, it is only actually curing for a fraction of that time. During the same 8-hour shift, an LED lamp will be “on” for significantly less time, resulting in a considerable reduction in energy consumption. Combined with the much longer life time of LED lamps (> 20,000 “on” hours), it makes LED lamps significantly cheaper to operate and results in a quicker return-on-investment. Another consequence of this is that there is no waiting period when an LED lamp is switched on at the beginning of the working day - the typical start time for LED lamps is 0.1ms.



The intensity of light produced by an LED lamp is typically one or two orders of magnitude greater than that produced by a wide-spectrum lamp. LED lamps are capable of generating up to 85,000 W/cm^2 (measured directly at the adhesive using a DELOLUX 80 400nm LED lamp), while for a wide spectrum lamp the light intensity will be in the region of low hundreds of W/cm^2, resulting in faster curing of the adhesive, shorter cycle times, and greater UPH when using LED lamps.

The following types of LED lamps are available from Inseto:

DELOLUX 20 & 202: Area Curing Lamps

DELOLUX 50: Spot Curing Lamp

DELOLUX 80: High Intensity Spot Curing Lamp

DELOLUX 820: High Intensity Area Curing Lamp

Process Control

Whether a mercury bulb lamp or LED lamp is used, it is critical to control the curing process as tightly as possible to ensure consistent results. That means that the intensity of the light that reaches the adhesive is the most important parameter to measure, not the power or the energy of the lamp. Light intensity is defined as radiation performance per area unit, and is typically measured in Watts per Centimetre Squared (W/cm^2). This can be controlled by changing the intensity of the light that the lamp produces, assuming that the lamp has this capability, or by altering the distance of the lamp from the adhesive - moving the lamp closer to the adhesive increases the intensity of the light reaching the adhesive, while moving it further away decreases the light intensity. It's difficult to define this relationship due to a number of factors, but in general, doubling the distance of the lamp from the adhesive reduces the intensity of the light by 30 - 40%, assuming no change in other variables.

The other factor to consider is the frequency of measurements. For a new production line, light intensity should be measure multiple times during each shift, whereas for more mature processes, daily or even weekly measurements can be taken. The type of lamp used will affect this: mercury bulb lamps, because of the wide variation seen in light intensity during the lifetime of a bulb, should have much more frequent measurements taken than for LED lamps, due to their significantly longer lifetime and minimum intensity variation during this lifetime.

Please click on the link for more information on Inseto's light measurement device, the DELOLUXcontrol.