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WHITE PAPER

ILLUMINATING CONCEPTS IN LED AND LCD PROTECTION

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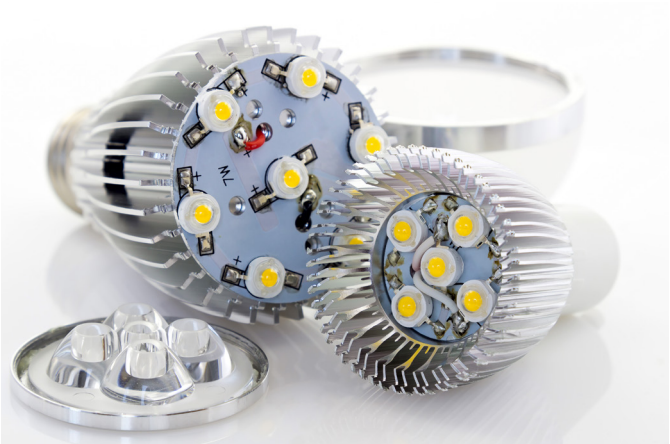
In the past decade, LED and LCD display technologies have become less expensive, easier to produce, and more energy efficient. As a result, these types of displays have taken the place of signs and placards, offering a more vibrant, noticeable, and modern design for communicating information to passersby. Growing numbers of LED and LCD displays present advertisements, services, menus, news, sports scores, road information, and systems status. Displays are made available in a wide spectrum of sizes—from the small, digital instrument panels that have replaced gauges and meters in aircraft, to the giant scoreboards located in sports stadiums that are discernable from as far away as the length of a football field. What do the above-mentioned LED and LCD sign applications have in common? Except for consumer devices, the majority are placed in locations where they must withstand a variety of environmental stresses:

- UV rays
- Moisture
- Wind-driven debris
- Temperature extremes
- Fluctuations in atmospheric pressure
- Finger smudges
- Vibration and shock
- Stray currents
- Vandalism

Manufacturers are able to produce quality LED and LCD displays, in large volumes and at competitive prices, due to the advantages provided by materials such as potting compounds, thermal compounds, and conformal coatings. These materials are integral to all aspects of LED or LCD panel manufacturing, from the electronics, to the optical lens, to the housing or casing of the display.



LEDs Made Easy

LED manufacturing relies heavily on adhesives and thermal compounds. LEDs convert electrical energy into light and heat when an electron meets a hole in the semiconductor and drops to a lower energy level. But up to 85% of the energy output is heat that can damage the circuit board. Thermal interface materials (TIMs) considerably improve LED lifespans as they keep sensitive components cool by carrying away destructive waste heat—the primary cause of electronics failure. A thermally conductive potting compound can envelop a semiconductor for protection, but will also help remove excess thermal energy.

A variety of liquid optically clear adhesives (LOCAs) are available for LED applications, each suited to different operating environments. UV-curing urethane acrylic compounds are easily dried by a simple light treatment, offer excellent substrate adhesion and flexibility, and are best for high temperature environments. Silicone-based adhesives are used when LED assemblies must operate in low temperature environments. These types of LOCAs are carefully formulated to have refractive indices that maintain or even improve the visual clarity of the LED assembly.

The roles of adhesive compounds go beyond thermal management or electronic protection techniques: they are also crucial to the assembly process. Many LEDs are packaged in a transparent, non-yellowing casting resin that protects the device from the environment, but may also improve the optical qualities of the LED. LEDs that utilize lenses or domes for protection will need a robust adhesive for bonding and sealing. Threadlockers can keep LEDs in place even when subjected to dynamic or shock loads. Liquid or tape adhesives seal the case of the LED display, and are quicker to install and better performing than mechanical fasteners.

Perhaps the best example of an LED display application that relies heavily on adhesive compounds and components would be road signs. Permanent signs provide critical traffic information, and bulletin-style signs must relay road closure and detour information while also being vehicle mounted. These signs are exposed to extreme temperatures, every type of precipitation, high winds carrying dirt and debris, corrosive road salt, and the constant vibration caused by passing traffic. They are also common in construction zones, the very nature of which demands a heavy-duty display with durable electronics. Thus, road sign manufacturers rely on robust-but-simple adhesive solutions to create enduring LED displays.

LCDs: Displaying the Importance of Adhesives

Ruggedized and commercialized LCDs fulfil too many applications to list. Many of the structural materials used for LEDs are also implemented in the assembly of LCDs. Some LCD panels use LED

backlighting that requires many LED protection technologies, as well as other considerations. Adhesives used in LCD assemblies must be optically clear, as they adhere a cover window or lens to a touch panel or LCD panel, as well as the touch panel to the LCD module. LOCAs play an important role in the optical clarity of LCD screens by protecting the more sensitive LCD module and touch panel from damage. They also eliminate air gaps between the sandwiched layers of a touchscreen display to improve contrast. With the proper choice of LOCA, in combination with a cover window of anti-reflective, anti-glare, and anti-smudge glass, the touchscreen remains vibrant and crystalclear in any scenario. A vivid display reduces device brightness requirements, in turn reducing power requirements and extending device longevity. LOCAs also have a high degree of reworkability, allowing lenses or touch panels to be repositioned before final curing. Some LOCAs can be easily peeled off once dried.

LCD design lends itself to UV curing methods, but areas where LOCAs cannot be exposed to UV light sources can be cured with activators, heat, moisture, or special tools. For years, silicone was the primary adhesive type used in LCD manufacturing, today other options are available. Developments in acrylate chemistry have improved LCD adhesive techniques and though these adhesives are typically more expensive, the cost is offset by more efficient throughput and extended panel service life. Furthermore, they can bond uneven surfaces while improving optical qualities.

LCDs: Delivering Military-Grade Protection

Military equipment is increasingly reliant on LCD screens, and these applications represent the pinnacle of LCD protection challenges. These displays are often placed on vehicles or mobile equipment, range in size from 7 to 37 inches diagonally, and their survivability in

the harshest environments is key to achieving mission objectives and assuring soldier safety. Military-grade LCDs must meet or exceed standards for any operation theatre, and so must their components. Resistance to cracking at arctic temperatures is important, but the display adhesive must also be optically clear in such conditions. Providing the best possible water ingress protection via liquid sealants ensures that equipment operates even after a soldier has marched through swamps and storms. Military pilots need clearly visible information on the status of all aircraft systems, whether cruising at supersonic speeds miles above the Earth or engaged in combat with airborne or ground-based adversaries.

But these military-grade panels don't require a bloated military-grade cost. Instead, standard LCDs can be ruggedized by the proper and proficient use of industrial adhesives, compounds and films. The optimal way to create an LCD capable of operating in -70 °F, in monsoon storms, or at 40,000 feet, is by investing in the most advanced adhesive solutions available.

Most LED and LCD processing doesn't require an advanced or complex solution. Instead, the expertise provided by Ellsworth Adhesives can apply progressive adhesive solutions to any display application at any scale. A dedicated engineered sales representative can evaluate your needs on-site, provide you with the best LED solutions available, and help you integrate the solutions into your manufacturing process.

WE ARE ELLSWORTH ADHESIVES

With 70+ experienced engineering sales representatives in North America and 200+ globally, Ellsworth Adhesives has the knowledge to provide complete specialty chemical solutions across multiple industries.

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