Taking the Heat
Silicone's unique properties help create the next generation of LED lighting

As global energy demand rises, the significant energy-saving potential of light-emitting diode (LED) lighting remains a top consideration for lighting manufacturers as well as designers, architects and consultants looking to offer clients more sustainable options. LED lighting uses one-tenth the power of standard incandescent lighting and lasts 25 times longer—it even has the long-term potential to produce more light, with less cost, than compact fluorescent lamps, or CFLs. In fact, LED lighting may soon replace most lighting in homes, offices, public spaces and in many other applications.

The challenge? Like incandescent light, today's brighter, white LED technology also creates heat. But the heat is in the component area (not in the light itself), and this can compromise performance and reliability. Heat causes LED lighting products made with traditional materials like epoxy to yellow with age, producing less light and even changing color temperature—a designer's nightmare. With the chip and components exposed to heat, longevity of the light declines, and many LED lighting products have not always been able to deliver on their claim of long lasting, efficient light.

But innovative, forward-thinking producers of LED lighting systems know something that many designers and other end users are discovering: Silicone can take the heat. Using silicone in LED lighting offers solutions to these challenges and the freedom to explore new styles and applications.

The silicone difference

Silicone is a heat resistant, sometimes rubber-like compound that withstands the elevated operating temperatures and short-wave exposures of today's brighter LED lighting. Silicone can manage heat better than epoxy, urethane, acrylic or other traditional materials used to fabricate LED-based lighting systems. Silicone designed for LED applications has excellent optical stability and transparency which results in little or no yellowing and greater reliability across the visible spectrum

Thermal and optical stability are the primary reasons that LED lighting made with silicone-based technology— such as wafers, molds, sealants, driver protection, optics, and thermal interface materials—provides light transmittance relatively well. In fact, ageing tests set at extreme temperatures (150C or 300F) for 200-hour periods show that silicone performs better than traditional, organic materials. These materials become significantly yellowed and cannot hold up against temperatures above 250° F (125° C)—a stark contrast to silicone's high performance.

Silicone can also be shaped to protect electronic components and to adhere to a variety of materials or substrates used within the lighting application, and it can better cushion fragile electrical components from outside stress. Silicone absorbs vibration, and with its low moisture uptake, it can also withstand harsh environmental effects. These properties, along with its thermal stability, offer lighting companies greater latitude in the shape, style or size of LED lighting as well as the types of applications they pursue.

"As new designs call for brighter, hotter and longer-lasting LEDs, we're seeing more and more companies turn to the power of silicone in applications where epoxies or COCs (cyclo olefin copolymers) were once the materials of choice," says Kaz Maruyama, global industry director of lighting at Dow Corning, one of the world's largest silicone producers.

LED lighting designed with silicone components conforms to industry standards and labeling requirements—another reason for designers and end users to feel confident.

Solutions span the lighting value chain

But what exactly are these components, and how are they used?

Silicone's properties benefit nearly every aspect of the solid-state lighting industry value chain: sealing, protecting, adhering, cooling and controlling light. Silicone technology like pottants, encapsulants, sealants and adhesives can resolve challenges in LED fabrication and packaging, as well as enable new designs and offer new solutions for electric components, housing and assembly in the LED lamp and luminaire industry. And finally, in the manufacture of optical systems, silicone can help resolve issues such as glare control, color temperature variation, performance over time, design limitations and more.

Across the production and supply chain, silicone can offer more thermal stability, transparency, light output and reliability, as well as easy processing ability and lower costs, than traditional materials. It is the material that can further the adoption of LED lighting, drive down costs, and enable successful expansion into exciting, promising new markets: general and accent lighting for home, office and retail spaces, traffic lights and other outdoor lighting, mobile devices, LCD displays, and automotive interior lighting. Applications requiring a cool touch and environmental toughness will especially benefit from silicone-based LED lighting.

“The lighting industry has gone through a huge transformation in the past five years,” explains Hugo da Silva, Dow Corning’s global market manager. “Before LED technology, heat was not an issue. So, many lighting companies may not yet realize the diverse ways that silicone can expand design options and enhance performance across the lighting value chain.”

Case in point: silicone encapsulants

Take just one finished product: an LED lamp. Over ten different silicone-based components, such as adhesives, pottants, secondary optics and electronics protection, can integrate to create a brighter, longer lasting, less expensive lighting product.

A closer look at just one of these components, silicone encapsulants, illustrates how silicone’s properties can create a better LED lamp. For example, LED semiconductor “chips” must be encapsulated, or covered, to enhance direct light and to protect them from dust, moisture and mechanical damage. The brighter LEDs favored by consumers

produce too much heat, discoloring older materials like epoxy and stressing the chip even more. Silicone encapsulants manage the heat and also increase light output by more closely matching the refractive index of the chip surface. Encapsulants and other silicone materials also enhance the already strong environmental credentials of LED lighting because they can be used in newer, lead-free solder processing and contribute to a significantly longer service life, reducing solid waste.

Dow Corning – a collaborator with silicone expertise

Many LED materials suppliers provide only some of the possible LED lighting components, and their commitment to research varies. The Dow Corning Corporation—a joint venture of Corning Incorporated and The Dow Chemical Company—is recognized as one of the few companies that provides solutions across the lighting value chain while offering research support for innovative, custom solutions. Dow Corning is known for bringing the benefits of silicone to diverse industries such as electronics and lighting. In fact, it can boast over 7,000 products and related services in its portfolio.

The company's reputation is built on a long history of innovation. Headquartered in Midland, Michigan, Dow Corning was established in 1943 specifically to explore and develop the potential of silicones. It has since grown to become a global leader in silicone-based technology and innovation.

Creating the next generation of LED lighting

The marketing, research and business development experts at Dow Corning recommend that those working in the lighting industry look beyond a catalog of silicone parts or plug-in components. A research giant like Dow Corning can collaborate within their business models and strategies and help bring innovative new designs and applications to market. It may be the best way for a lighting company to expand its offerings, gain a competitive edge, and increase the adoption of LED lighting in the general market. In fact, Dow Corning is one of the few silicone LED materials suppliers that actively seeks opportunities to develop the next generation of lighting alongside designers, architects and manufacturers.

Dow Corning draws on its strong research and development departments (the company devotes five percent of sales to R&D) to further silicone-based LED innovation. The company maintains development and applications centers throughout Asia, Europe and the United States to invite customers to develop innovative new products and to further its own long-term research agenda.

“We’re confident that anyone working in lighting will find a silicone solution at Dow Corning to meet their needs and gain the benefits of LED lighting,” says Maruyama. “But if they don’t see what they need, we can help create it. We believe the real breakthroughs in expanding LED technology will come through a breadth of silicone product offerings, innovative game-changing products, and close collaboration with our customers.”