

EXCLUSIVE NICHIA MID-POWER LED PACKAGE DESIGN ADVANCES LUMEN AND COLOR MAINTENANCE

Proprietary thermoset composite outperforms plastic and ceramic packages

A continuous-improvement mindset among Nichia researchers and scientists and the company's drive to optimize LED performance through materials science have produced an exclusive light-emitting diode (LED) package innovation expected to speed and deepen LED system adoption across a range of general and specialty applications. These include directional, general, linear, B/L, auto and video—approximately 80 percent of LED solutions in place today, based on Nichia estimates.

Nichia re-invents LED package design with proprietary thermoset composite

Nichia's 757 series mid-power, small-die LED package with proprietary thermoset composite material delivers efficacy and value beyond current high-power LED capabilities and performance above other commercially available mid-power LEDs, which regularly demonstrate rapid lumen depreciation and big color shifts over short periods of time.

Primary mid-power vs. high-power design advantages consist of:

- *Economies of scale* that improve the total cost of solutions;
- *Manufacturing yields* as multiple small dies drive higher yields and lower costs;
- *Design flexibility* enabled by more reliable color consistency and a larger variety of electrical configurations; and

- *Cutting-edge performance* featuring a significant, up to 50 percent lower cost of light.

Thermoset composite packaging holds great promise as a next-generation solution because predecessor LEDs broke application barriers. Mid-power LEDs have been used in virtually every retrofit and new SSL application of the last decade (see Figure 1).



Figure 1 — Performance improvements in widely used mid-power LEDs enable higher quality, longer lasting lamp and fixture solutions.

Unique design attributes in Nichia's 757 series LEDs ensure greater reliability while delivering visual comfort with low luminance, uniform light distribution and tighter color control. Its differentiation rests with the proprietary thermoset composite packaging materials that Nichia has paired with high-efficiency LED chips and specially blended phosphors.

LM-80 and TM-21 reports from Nichia certify reliability over a 50,000-hour rated life.

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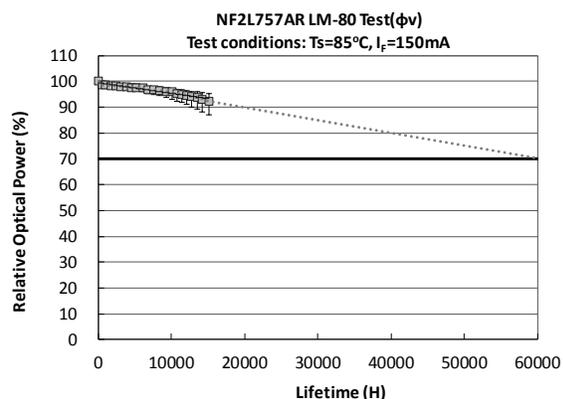
Ever Researching for a Brighter World

Nichia adheres to the lumen maintenance and color maintenance standards set forth by the Illuminating Engineering Society of North America (IESNA) LM-80 standard (see Figure 2) for US EPA Energy Star qualification at 55°C and 85°C. Nichia goes one step further by testing its LED up to 105°C.

LEDs are free from plastics containing benzene ring structures (see Figure 3). Benzene ring, a common chemistry in many plastic LED packages, tends to degrade under photon energy.

When thermoplastic LED package materials such as Polyphthalamide (PPA) contain a benzene ring in a molecular structure, discoloration builds up through oxidation and photoexcitation.

(a)



(b)

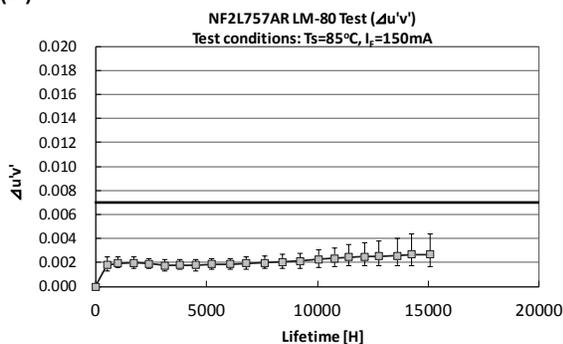


Figure 2 — Nichia 757 series LED LM-80 report on (a) lumen maintenance and (b) color maintenance.

The fundamental difference between previous LED package designs and Nichia's 757 series LED design emerges in an examination of lumen maintenance and color maintenance data. Nichia 757 series

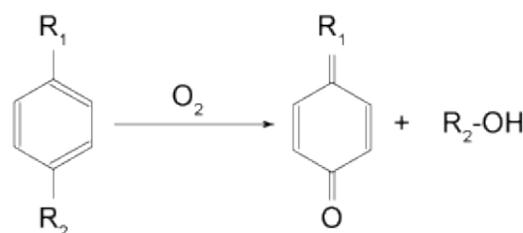


Figure 3 — Photoexcitation decomposition in a benzene ring molecular structure.

Moreover, an amide bond contained in PPA can decompose with exposure to the heat produced by operating LEDs. This results in a string of problems starting with a discolored LED package (yellowing), followed by a reduction of reflectivity, and eventually, significant lumen degradation and color shift (see Figure 4).

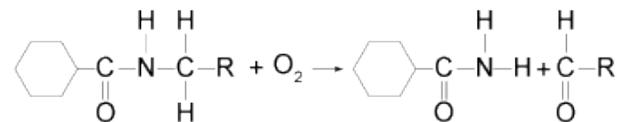


Figure 4 — Decomposition in an amide bond molecular structure.

Nichia's proprietary package design—a new alternative to lower cost pure plastic or



higher cost pure ceramic packages—combines thermoset composite and inorganic materials (see Figure 5) to enhance reflectivity and reinforce structural stability. The package also shows excellent environmental robustness in corrosion resistance, even at elevated temperatures.

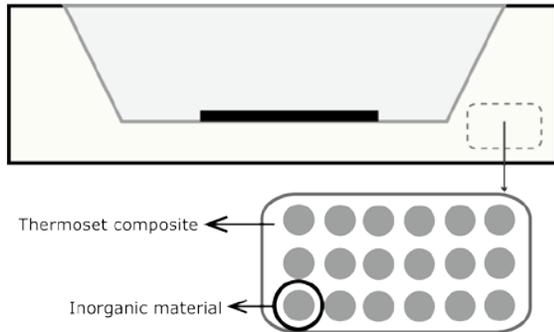


Figure 5 — Exclusive Nichia 757 series LED thermoset composite package material illustration.

Nichia testing overview

Nichia testing indicates that SSL products employing its new 757 series LEDs will withstand harsh environmental conditions without losing significant light output over time (see Figure 6).

- I_f 65mA, 75%RH, H2S 1ppm + NO2 2ppm*
- Time - 192 hours (equals 4-5 years in a real-world environment).
- *Per ISO11844, indoor corrosivity categories IC4 (e.g., electrical service rooms, industrial plants, churches in polluted areas, and outdoor boxes for telecommunication in polluted areas).

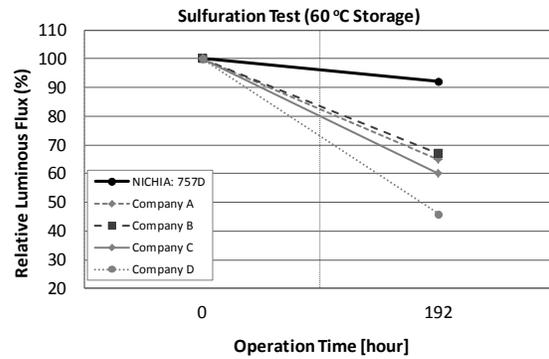


Figure 6 — Corrosion resistance test results for Nichia 757 series LEDs compared with four commercially available plastic LED packages.

Another test of high-temperature, high-humidity performance (see Figure 7) further validates the science-based toughness of Nichia 757 series LEDs.

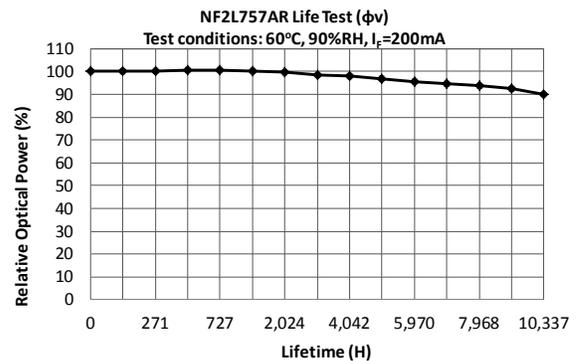


Figure 7 — High-temperature, high-humidity test results for Nichia 757 series LEDs.

Key considerations

Mid-power LEDs are poised to drive broad adoption of LED solutions with high performance and lower costs.

Nichia has virtually eliminated the root causes of rapid lumen depreciation and color shift in mid-power LEDs.



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ABOUT NICHIA

Headquartered in Tokushima, Japan, Nichia is the world's largest supplier of LEDs. It designs, manufactures, and markets LEDs for display, LCD backlighting, automotive and general lighting applications with the broadest product portfolio across the entire visible and UV spectrum. Nichia strengthens its leadership position through innovation, in-depth research and development, and continuous investments in manufacturing and quality excellence. Nichia's invention and development of white LEDs has been the foundation of the global advancement of energy efficient, environmentally friendly solid-state lighting.

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