INNOVATIVE PLASTICS
BOLD+ BRIGHT
ADVANCED MATERIALS FOR LED DESIGN

CHEMISTRY THAT MATTERS™
Innovative Plastics is a strategic business unit of SABIC. Founded in 1976, SABIC is today the first public, global multinational enterprise headquartered in the Middle East. Our products range from bulk commodity chemicals to highly engineered plastics for demanding applications. We’re a leading supplier of polyethylene, polypropylene, glycols, methanol and fertilizers, and the world’s fourth largest polyolefin producer.

SABIC’s businesses are grouped into Chemicals, Performance Chemicals, Polymers, Innovative Plastics, Fertilizers and Metals, representing a vast portfolio of products and services aligned to assist customers with end-to-end solutions anywhere in the world.

From logistics to technology to innovation and support, we’re here to help. Our dedicated Technology & Innovation Centers are strategically located – in Saudi Arabia, the Netherlands, Spain, USA, India, China and Japan – ready to serve our customers and business partners with the resources they need to create lasting competitive advantage in the global marketplace.
INNOVATING FOR CUSTOMER SUCCESS

We believe that SABIC customers deserve the full benefit of our broad portfolio of products and solutions. After all, our success is defined by our customers’ success. And with over 80 years of experience pioneering advanced engineering thermoplastics, SABIC’s Innovative Plastics business is striving to help our customers create new opportunities for growth and breakthrough applications.

We offer expertise and experience to our customers in a variety of ways:

• Material solutions to help drive innovation and market leadership
• Design, logistics and processing expertise to spark new ideas and better efficiencies
• Unwavering commitment to build long term relationships with ingenuity, trust and continuous improvement

It’s what we strive for and work to deliver… a mutual benefit.

Excellence and nothing less.
A BRIGHT FUTURE IS DAWNING FOR LEDS

SABIC is helping them shine. Delivering more energy-efficient illumination and potentially longer lifetimes than conventional light sources, light-emitting diodes (LEDs) also pack a rainbow of intense colors into compact form factors. The bold new options these solid-state sources introduce to lighting design have attracted interest from OEMs in residential and commercial lighting, automotive, architectural illumination, displays and dozens of other industries.

Through its global Innovative Plastics business, SABIC offers LED makers an extensive portfolio of specialty resins and compounds. And with that portfolio comes the technological expertise, personal drive and collaborative culture to help you optimize the performance, lifespan and aesthetics of your LED sources and lighting designs.

Compared to conventional glass, silicone or metal materials, SABIC’s leading-edge engineering plastics introduce expanded design freedoms through lower weight, better mechanical properties, enhanced aesthetics and fewer secondary operations. Combining the industry’s widest selection of materials platforms with decades of design expertise, our Innovative Plastics business supports a wide spectrum of performance solutions for LED design consideration, including:

- Transparency and diffusion
- Flame resistance (non-brominated, non-chlorinated, non-phosphorus)
- Heat resistance
- Direct metallization
- UV resistance and weatherability
- Thermal and electrical conductivity
- Impact resistance
- Excellent moldability
- High reflectivity
TRANSPARENT GRADES

The clear choice: LEXAN™ resin (a polycarbonate material) – Optical clarity and more for transparent LED applications.

LED light-guides, lenses and other components often demand stronger or more focused emission of light. In these applications, transparent grades of LEXAN polycarbonate (PC) shine, delivering high transmission of light plus other high-value performance qualities.

Transparent LEXAN LUX resins offer expansive design freedom for LED light-guides through excellent processability and a broad range of flow profiles. Plus, they offer better impact resistance than glass, as well as flame-retardant options unavailable from competitive plastic materials like PMMA (acrylic).

These qualities make LEXAN LUX resin an excellent candidate for transparent LED assemblies that must meet stringent requirements for heat and impact resistance.

LEXAN resin is available globally, and offers critical performance characteristics, such as:

- Excellent processability
- Flow availability (g/10 min, 300 °C/1.2 kg)
- Improved optical clarity (Also for thick flame retardant lenses)
- Superior high transmission
- Heat resistance
- High impact/almost unbreakable
- Flame-retardant availability
- Improved heat aging properties

**GENERAL PURPOSE TRANSPARENT**

- 18 MFI, V2 @ 0.75 mm
  - LUX2110T
- 18 MFI, V2 @ 0.75 mm (f1)
  - LUX2180T
- 40 MFI, V2 @ 0.75 mm
  - LUX2010T
- 60 MFI, V2 @ 1.5 mm
  - LUX2910T

**FLAME-RETARDANT TRANSPARENT**

- 8 MFI, V0 @ 1.5 mm (f2)
  - LUX9610T
- 14 MFI, V0 @ 3.0 mm (f1)
  - LUX9230T
- 18 MFI, V0 @ 1.5 mm
  - LUX9130T
  - 5VA @ 6 mm, (f1)
- 10 MFI, V0 @ 1.2 mm
  - LUX7430C
  - 5VA @ 3 mm, (f1)
- 5 MFI, V0 @ 1.0 mm
  - LUX7630C
  - 5VA @ 3 mm, (f1)
Aging stability: LEXAN LUX21x0T resin vs. standard PC w UV additive

**FIGURE 1 - 2.5 MM COLORSHIFT HEAT AGING AT 130 °C**

![Graph showing colorshift heat aging at 130 °C]

**FIGURE 2 - TRANSMISSION SHIFT HEAT AGING AT 130 °C**

**FIGURE 3 - TRANSMISSION 420 NM SHIFT HEAT AGING AT 130 °C**

New LEXAN LUX resin grades show superior color stability
Flame-resistant solutions for transparent and diffuse LED applications

Flame-retardant (FR) materials are one of the main requirements for LED designs, and SABIC offers a broad range of solutions for both transparent and diffuse lighting applications. Select globally available grades deliver flame resistance meeting UL 94 up to 5VA standards in thin wall configurations, as GWFI (IEC) up to 960 °C. Plus, designers can expect additional performance characteristics, including excellent processability, low weight, high impact strength, strong heat resistance and compliance with environmental protocols governing non-brominated, non-chlorinated and non-phosphorus FR systems.

Our wide portfolio of engineering resins encompasses potential solutions for virtually any shape and standard required for retrofit light bulb designs and other LED luminaire applications.

**OPTICALLY CLEAR FLAME-RESISTANT SOLUTIONS**

For LED light bulb, spotlight and tube designs targeting the lighting market, SABIC offers select flame-resistant LEXAN resin grades that:

- Are listed UL 94 V0 up to 1 mm, 5VA at 3 mm for NAFTA and according to IEC standards (Europe) for GWFI up to 960 °C with BPT 125 °C (Europe)
- Enable high transmission across the visible spectrum
- Offer moldability and flow for open or directed beam designs
- Offer extrusion grades for flame-resistant tube designs
- Include FR grades for diffuse/transparent applications

Additionally, we provide some grades with UL746C, F1 rating for outdoor applications (see product tree, page 12).

* Non brominated & non chlorinated & non-PTFE used FR System
LEXAN LUX Resin Diffusion Solutions

Potential Benefits of LEXAN Copolymers

- Improved flame resistance - thinner wall V0 performance over standard clear FR PC resins
- New flame resistance capability - 5VA performance over clear FR PC resins
- Non-brominated, non-chlorinated, non-phosphorus and no PTFE added
- UL746C f1 rating
- Standard PC type optical properties
- Improved melt flow and process capability over existing clear FR PC resins
From clear to diffusion

Products with broad optical properties to cover LED many applications

<table>
<thead>
<tr>
<th>MFR 18</th>
<th>UL94 V2@ 0.75 mm</th>
<th>LUX9114C WH8B80X</th>
<th>LUX9114C WH8B80X</th>
<th>LUX9114C WH8B80X</th>
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<th>LUX9611G WHAB80X</th>
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<tr>
<th>MFR</th>
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<th>LUX9130C NAT</th>
<th>LUX9130C NAT</th>
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<tr>
<th>MFR</th>
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<th>LUX9130C NA8E061T</th>
<th>LUX9130C NA8E061T</th>
<th>LUX9130C NA8E061T</th>
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* Transmission: percentage of the incident light that is transmitted

* Degree of light dispersion (DLD): angle at which half of the luminance of the incident light is observed

**FIGURE 4 - DEGREE OF LIGHT DISPERSION (DLD)**
Diffuse lighting applications signify a large potential market opportunity for LED lighting applications, and SABIC can support lighting design solutions. We are the first resin supplier to offer FR diffusion materials with UL-rating in all colors, including RTI (long-term) grades. We provide almost limitless aesthetic and light management design options for LED retrofit light bulbs and tubes.

DIFFUSE LED LIGHT BULBS/LUMINARIES

- Flame-retardant: Listed for UL 94 up to V0 1.0 mm and 5VA up to 3 mm (NAFTA), and according to IEC standards (Europe) for GWFI up to 960 °C/BPT 125 °C (Europe)
- RTI listed up to 125/115/125 °C
- Excellent light management enables high transmission with hiding power
- UV/thermal stability for light fastness

DIFFUSE LED RETROFIT TUBES

- Flame-retardant: Listed for UL 94 up to V0 1.0 mm and 5VA up to 3 mm (NAFTA), and according to IEC standards (Europe) for GWFI up to 960 °C/BPT 125 °C (Europe)
- RTI listed up to 125/115/125 °C
- Excellent light management enables high transmission with hiding power
- UV/thermal stability for light fastness
- Extrusion grades for flame-resistant tube designs

SABIC has both diffuse and transparent flame-retardant grades – excellent candidate materials for your application needs.
HIGH-REFLECTIVE GRADES
SABIC delivers high-reflective material for LED lighting reflectors. The reflectivity goes up to ~97%, depending on wall thickness and wavelength. (see graph example of LEXAN LUX2489D resin in color WH6F005 below). Option also available with anti-dust properties if needed.

EXTRUSION
- 7 MFI, V2 @ 1.6 mm
  - LEXAN LUX2619
- 12 MFI
  - GWFI 860 °C @ 1.8 mm
  - LEXAN LUX2489D
  - Anti Dust
- 17 MFI, V2 @ 1.6 mm
  - LEXAN LUX2289
- 22 MFI V0 @ 1.5 mm
  - 5VA @ 3 mm
  - RTI 120/105/120 °C
  - LEXAN LUX7189
- 22 MFI V0 @ 1.0 mm
  - RTI 120/105/120 °C
  - LEXAN LUX7169
- 22 MFI, HB @ 1.5 mm
  - LEXAN LUX1169
- 14 MFI V0 @ 0.8 mm
  - 5VA @ 1.5 mm
  - RTI 120/105/140 °C
  - BPT > 175 °C
  - VALOX DR48V
- TC 1.5 W/mk
  - V0 @ 1.0 mm
  - KONDUIT PX11311(U)

INJECTION MOLDING

FIGURE 5 - REFLECTIVITY OVER WAVELENGTH AND THICKNESS
The reflectivity reported is the reflectivity over 420-700 nm, as measured with a Perkin Elmer LAMBDA† 950 spectrophotometer with 150 mm reflective sphere, Spectralon† coated.
LIMIT LED HEAT – NOT LED DESIGN

LNP™ KONDUIT™ compounds for thermal management

Although LEDs generate light five times more efficiently than conventional incandescent lamps, much of their input energy still converts into heat that – if not managed – can detract from an LED’s optimal useful lifetime. As demand rises for LEDs with higher efficiencies and longer life spans, thermal heat management will be more and more critical to competitive designs.

This poses a potential problem for conventional heat sink materials, such as die-cast aluminum, since they can impose limitations on LED design and require costly secondary operations. Thermal conductive compounds, such as SABIC’s LNP KONDUIT material, offer a valuable alternative.

LNP KONDUIT compounds are based on thermoplastics loaded with special fillers to enable thermal conductivity. They deliver lower weight than aluminum or other conventional metal solutions, and a higher mechanical impact resistance than ceramic solutions. Our materials offer ease of processability and need no secondary operations. Plus, they provide tremendous design freedom when balancing form and function.

LNP KONDUIT compounds offer thermal conductivity up to 15 W/mK in combination with electrical isolation to pass industry electrical standard-6KV breakdown tests. The materials are available with UL 94 listing up to V0 @ 0.8 mm with a non-halogenated flame-retardant system. Available in white, gray and black, they also offer a range of aesthetic options.

* Thermal conductivity measured with Hotdisk TPS2500 in-plane with a 3 mm plate (60 by 60 mm, film-gated).
HIGH HEAT, HIGH PERFORMANCE

Heat-resistant LEXAN XHT resins for high-temperature performance

Many LED components and applications – including spotlights, flashlights, light-guides, lenses and reflectors – often demand an extra degree of heat resistance. Formulated from a unique high-heat polycarbonate copolymer, LEXAN XHT resins retain their clarity and mechanical properties far longer than comparable polycarbonate materials. In addition, they deliver other key advantages to your LED design:

**PROCESSABILITY**
LEXAN XHT grades deliver an excellent flow profile compared to other high-heat resins, expanding design freedom and production efficiencies.

**MECHANICAL PROPERTIES**
Like all LEXAN resin grades, LEXAN XHT resin offers excellent impact resistance, but also retains its tensile strength longer than comparable polycarbonate grades at elevated temperatures.

**DIRECT METALLIZATION**
LEXAN XHT resins’ high heat resistance expands options for direct metallization of lightweight plastic LED components, such as lens reflectors. In addition to improving performance, this can also help reduce cost and cycle-time related to secondary operations.

**UV STABILITY AND WEATHERABILITY**
Compared to other high-heat polymers, LEXAN XHT resin offers better UV resistance and weatherability, making it an excellent option for outdoor LED lighting applications.

<table>
<thead>
<tr>
<th>HDT (°C)</th>
<th>MFI (g/10 min)</th>
<th>Standard</th>
<th>UV Stabilized</th>
<th>High Release</th>
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<tbody>
<tr>
<td>165</td>
<td>26</td>
<td>XHT4141</td>
<td>XHT4143</td>
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<td>156</td>
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<td>135</td>
<td>70</td>
<td>XHT1141</td>
<td>XHT1143</td>
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</tbody>
</table>
OUTSTANDING PERFORMANCE UNDER THE SUN

UV-resistant LEXAN SLX resin stands up under extreme weather

Specially formulated to deliver improved long-term weatherability, LEXAN SLX polycarbonate (PC) resin resists yellowing due to ultraviolet (UV) exposure and retains its excellent gloss, color stability and mechanical properties more than five times longer than standard PC. Plus, these same qualities mean using LEXAN SLX PC resin can help reduce or eliminate costly secondary operations to apply UV coating. Available in either transparent or diffuse color options, it is a superb candidate for LEDs designed for outdoor and street-lighting applications. Available in natural, with limited white diffuse colors also available.

WEATHERING MATERIAL BEHAVIOR SIMULATION

3 years simulated weathering

< PC + UV RESIN

< LEXAN SLX RESIN

6 years simulated weathering

< PC + UV RESIN

< LEXAN SLX resin

1 In hot chamber, 175W MH lamp for 2900 hours @ 120 °C on refractor – 55 °C ambient.
LEXAN SLX COPOLYMER PREFERRED PRODUCT TREE

EXTRUSION & BLOW MOLDING

3 MF  SLX 2571T  UL94 V2 @ 1.5 mm

7 MF  SLX 2071T  UL94 V2 @ 1.5 mm

INJECTION MOLDING

10 MF  SLX 2471T  UL94 V2 @ 1.5 mm

17 MF  SLX 2271T  UL94 V2 @ 1.5 mm

INNOVATIVE PLASTICS 15
A WIDE SPECTRUM OF MATERIALS SOLUTIONS

SABIC is your one-stop shop for engineering thermoplastics. In addition to the high-performance resins already outlined, we offer a broad range of additional materials platforms that are excellent candidates for just about any application need. Plus, we continue to push the boundaries of performance by innovating new materials technologies every day.

ULTEM™ RESINS

Many LED applications require housings or reflectors that must deliver durable performance under high temperatures. ULTEM amorphous thermoplastic resins, polyetherimide (PEI) materials, are an excellent candidate.

Their outstanding resistance to extremely elevated temperatures means ULTEM resins deliver long-lasting strength and stiffness, as well as broad chemical resistance under the most demanding conditions.

Select ULTEM copolymers can meet even higher heat, chemical and elasticity needs. Available in transparent and opaque custom colors as well as glass-filled grades, ULTEM resins balance mechanical properties and processability, offering design engineers exceptional flexibility and freedom.

KEY PROPERTIES OF THE ULTEM RESINS

BASE POLYMER:

• High long-term heat resistance exhibiting a glass transition temperature of 217 °C (422 °F), HDT/Ae of 190 °C (374 °F) and relative thermal index (RTI) of 170 °C (338 °F)
• Inherent flame retardancy with low smoke evolution, meeting ABD, FAR and NBS requirements
• Excellent dimensional stability (low creep sensitivity and low, uniform coefficient of thermal expansion)
• Exceptional strength and modulus at elevated temperatures
• Good resistance to a broad range of chemicals such as automotive fluids, fully halogenated hydrocarbons, alcohols and aqueous solutions
• Stable dielectric constant and dissipation factor over a wide range of temperatures and frequencies
• Transparency to visible light, infrared light and microwave radiation
EXTEM™ RESINS

EXTEM resins combine high-end performance and easy processability, letting you challenge the conventional design rules for thermoplastic polyimides, and explore mainstream applications for these once exotic, low-volume resins. They deliver excellent metallization and adhesion under long-term, high-heat conditions without the need for a primer or base coat.

In addition, EXTEM resins provide true thermoplastic melt processability with ultra-high performance as molded. Unlike PAI and PI polymers, they don’t require post-cure or crystallization steps to yield maximum performance. Combining good metallization, flow and high-temperature performance, EXTEM resins and blends with semicrystalline resin make outstanding candidates for LED reflectors. Specifically, they enable thin-walled LED reflectors to withstand extreme humidity with acceptable dimensional changes.

KEY PROPERTIES OF EXTEM RESINS:
- Tailorable glass transitions up to 311 °C (592 °F) per application requirements
- Extended application use temperature as high as 250 °C (482 °F)
- Unfilled vs. glass-filled PPA and LCP means better surface finish and lower weight
- Extreme amorphous chemical resistance
- High strength, stiffness and creep resistance at elevated temperatures; exceptional dimensional stability
- Inherent flame retardancy, as well as outstanding flame, smoke and toxicity
- Recyclability
**VALOX™ RESINS**

A versatile materials solution, VALOX resins, a polyester material, include performance-matched grades designed to provide application-specific property profiles. VALOX resins combine heat and chemical resistance as well as outstanding electrical properties with exceptionally good processability and surface appearance. Select grades offer non-brominated and non-chlorinated flame retardant properties.

**KEY PROPERTIES OF VALOX RESINS:**
- Highly tailorble mechanical, thermal and electrical properties combined with excellent dimensional stability
- Excellent resistance to a variety of chemicals, including hydrocarbons, dilute acids and bases, detergents and most aqueous salt solutions
- UV stable, F1 listing
- Available in a broad range of both filled and unfilled grades, with specified UL and other agency compliance ratings
- Flame-retardant grades offer a UL94 5VA rating and a glow wire test (GWT) pass at 960 °C (1760 °F)
- Relative temperature index (RTI) up to 140 °C (284 °F), yet provide good low-temperature performance to -40 °C (-40 °F)
- SMT, high reflectivity, good whiteness retention
- Up-cycled sustainable solution VALOX iQ™ resins

**TYPICAL APPLICATIONS AND GRADES:**
- Shell (socket): (iQ)ENH4550, (iQ)ENH4565
- Street LED lighting housing: (iQ)357U, V3900WX
- LED chip reflector

**VALOX ENH4565 RESIN**

A 33% GF PBT resin, non-brominated and non-chlorinated flame-retardant, injection molding grade for applications that demand low CTE, good thermal shock resistance and ductility.

**PO TENTIAL BENEFITS**
- Non-brominated and non-chlorinated, flame retardant
- Good thermal shock resistance
- Super weld line strength
- Low CTE: Narrow CTE gap between plastics and metal for over molding application
- Good tensile and impact strength, Thin wall FR and high RTI: V0@0.8 mm, RTI@130 °C

**PO TENTIAL APPLICATIONS**
- Applications needing good thermal shock resistance, such as lighting socket and cooling fan
- Applications needing good weld line strength, such as cooling fan frame
- High tensile and impact strength applications, such as EV charging coupler

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**BROAD PORTFOLIO OF HIGH-PERFORMANCE RESINS**

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<tr>
<th>Resin</th>
<th>Blends/Compounding</th>
<th>Forward Integration</th>
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<tbody>
<tr>
<td>LEXAN PC resins</td>
<td>CYCOLOY™ resins</td>
<td>SF&amp;S (Sheet/Film)</td>
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<td>CYCOLAC™ resins</td>
<td>GELOY resins</td>
<td>PC</td>
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<tr>
<td>ULTEM resins</td>
<td>NORYL GTX™ resins</td>
<td>LNP Specialty Compounds</td>
</tr>
<tr>
<td>VALOX resins</td>
<td>ULTEM ATX resins</td>
<td>using all SABIC® resins and blends - but also PA, PP, POM and PEEK</td>
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**Forward Integration**
- SF&S (Sheet/Film)
- Blends
- LNP Specialty Compounds
- THERMOCOMP™ structural resins
- KONDUIT thermal conductive resins
- LUBRICOMP™ /LUBRILOY™ lubricated resins
- STATKON™ conductive resins
- STATLOY™ anti-stat resins
- FARADEX™ EMI shielding resins
- VERTON™ continuous fiber resins

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SUSTAINABLE INNOVATION

Sustainable practices are not just the right thing to do for the environment, they are also a smart business strategy. SABIC has a long history of positive contributions to the sustainable performance of our customers’ products – and to our own. We continue to invest in materials, technologies and processes that help customers worldwide lower their carbon and energy footprints, eliminate waste and ensure strict compliance with global environmental regulations.

Specifically, for LED applications, our advanced flame-retardance systems can replace hazardous flame-retardant (FR) substances that face increasing restrictions around the world. The 2006 Restriction of Hazardous Substances (RoHS) Directive (2002/95/EC, as amended) banned the use of certain hazardous substances in electrical and electronic (E/E) equipment in the European Union (EU). The EU Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC, as amended) mandates separate disposal processes for products containing any RoHS substance, which adds costs and makes recycling more difficult. Similar legislation is being developed in other parts of the world, and the RoHS list of substances is expected to grow. Chlorinated and brominated flame retardants have also come under scrutiny due to concerns about by-products that may form during incineration.

For years, SABIC’s Innovative Plastics business has offered non-brominated FR resins, such as the LEXAN 9x5 resin series, and halogen-free FR resins such as the LEXAN 9x9 resin series and ULTEM and Flexible NORYL resin grades. We continue to expand this portfolio with new functionality and improved technology to help our customers develop applications that will meet their entire list of quality criteria.
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