In the spotlight

LEDs are gaining a firm place in the lighting industry and beyond. And Evonik is shaping the future of this growing market.

The latest generation of lamps is synonymous with energy-saving. Light-emitting diodes (LEDs) are already found in a wide variety of applications, from rear lights and indicators in automobiles through traffic signals to flashlights and bedside lamps. And soon environmentally friendly LED lamps will be revolutionizing our living rooms. The growing market for LEDs offers many new uses for Evonik's products—from advertising signage to the sterilization of water.

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Evonik. Power to create.

Incandescent light bulbs have now been banned from our homes and energy-saving bulbs are also losing ground because they have one big disadvantage: They contain traces of mercury, so they have to be disposed of as hazardous waste. Now, a completely new generation of lamps based on light emitting diodes (LEDs for short) is starting to gain access to our homes. LEDs comprise two semiconductors with different properties. Passing a current between them creates light. The diode is covered with phosphorus, which triggers its light-emitting properties. The shade of the light varies depending on the colorant selected and how much is added.

Given the debate about climate protection and rising electricity prices, it is becoming increasingly important to ensure that our lighting is as energy-efficient as possible. While incandescent light bulbs can reach temperatures of around 300 °C and thus ignite readily flammable materials, the maximum temperature of LEDs is around 40-50 °C. They are therefore classed a low fire risk and are regarded as being safe for children. The problem with LEDs is that the technology itself has low heat resistance, so they are not

Light sources of the future: In the bulb are light emitting diodes (LEDs.) These are semiconductor that emit light when an electric current passes through them.

yet suitable for applications such as lighting above cookers. Another drawback is that so far they generate little to no white light. However, that is about to change.

Bright light that uses less power

The new technology is advancing. Compared to conventional light sources such as incandescent and energy-saving light bulbs, LEDs today achieve a higher degree of energy efficiency and greater freedom of design. Unlike energy-saving bulbs, LEDs are instantly bright when they are switched on. Moreover, they last longer and are free of toxic materials. They contain no mercury, which has to be disposed of at a recycling dump. The new high-tech LEDs are expected to last for 20 to 25 years compared with an average of just 800 hours for conventional light bulbs, depending on their wattage. Thomas Hermann, who heads Evonik's Inorganic Materials Business Unit, therefore sees good business prospects for LEDs: "The LED revolution is already here and the market is expected to grow by over 20 percent a year. We're convinced that LEDs will become an effective everyday lighting solution, enabling everyone to make a contribution to saving energy." The growing demand for LEDs is driven by the latest megatrend "green lighting", in other words, environmentally friendly light sources. Regulations such as the ban on incandescent bulbs and upcoming legislation requiring automobiles to drive with lights even in the daytime are also boosting this trend.

The next generation of LEDs

The lenses surrounding an LED can be made of glass or plastic. Evonik offers optimal solutions for both alternatives. Its joint venture with the Taiwanese company Cristal Material Corporation is developing SavosilTM glass lenses for the next generation of LEDs. These innovative lenses are used in high-end white-light LEDs—the lighting technology of the future. Warm white LED lamps will probably gradually replace halogen lighting and energy-saving bulbs. In fact, the novel light sources can also be used in scanners, portable projectors and as back-lighting for flat-screen displays (LCD-TV) and computer monitors. These LED lenses are manufactured from AEROSIL® and Dynasylan® using the SiVARATM sol-gel process patented by Evonik. A solution or dispersion containing AEROSIL® is cast to obtain the required shape.

Impressive effect: Leipzig's Nova Eventis shopping mall is bathed in a suitable light according to the time of year. The shining highlight of this spectacular lighting display is the 12-meter-high luminous globe made of PLEXIGLAS truLED®. The globe's outer skin is made of 576 PLEXIGLAS® "sequins" that overlap like scales. Each sequin is illuminated by an LED spotlight. Altogether there 376 LED spots inside the globe, each of which can be controlled individually and is equipped with three high-performance LEDs. Each LED contains the colors red, green and blue.

This forms a gel which solidifies after several processing steps to form what is known as a sol-gel. Finally, it is fired in a furnace to produce transparent, high-purity silica glass. As an added benefit, the glass protects the phosphorus in the lenses from moisture and heat, so the lenses can also be used for outdoor lighting. Sol-gel transformation is the name of this process which allows the production of glass lenses of consistent quality in any desired shape. And that opens up endless creative options for everything from serial production to extremely complex designs.

Evonik also relies on its expertise in plastics. With its PLEXIMID®, a molding compound made of polymethylmethacrylamide (PMMI), Evonik offers yet another material that is particularly suitable for manufacturing lenses and light guides, for example, in the headlights of vehicles. PMMI can take the extremely high heat produced by powerful LED spotlights. In this application, good thermoforming stability and consistently good optical properties are a prerequisite. PLEXIMID® meets these requirements. Moreover, both this special molding compound and the silica glass produced from AEROSIL® allow all kinds of design possibilities.

Boundless creativity

LEDs are becoming an established feature in outdoor signage, too. Flashing illuminated signs made of Evonik's design material PLEXIGLAS® are already a common sight in modern large cities. Innovative technologies from Evonik combine climate protection with cost-efficiency: PLEXIGLAS truLED® was specially developed for today's LED technology and is made to suit exactly each color co-

ordinate of the LED, offering high transmission combined with excellent light diffusion. This lowers by up to 40 percent the power consumption of objects that are equipped with LEDs, compared to ordinary acrylic glass. These particular properties make it possible to avoid undesirable and distracting hot spots—visible cones of light—or fluctuating light intensity, even in compact designs.

Development of a further application: UV purification

Other growing applications for the LEDs are solar cells and the activation of chemical processes (UV polymerization). Moreover, smart UV LEDs can be used to purify water: They use ultraviolet light to tackle germs in water. Robust diodes attack the genetic structure of water-borne pathogens and render them harmless. UV LEDs are an environmentally friendly and affordable alternative to low-pressure mercury bulbs. Their salient features include efficiency and a long service life. The challenge that the further development of UV LEDs is facing is being able to ensure the same efficiency and longevity that is typical of LEDs used in the home.

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