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Features

Number 7, November 2009

Let There Be LEDs: Silicones Simplify the Production of Energy-Saving, Climate-Protecting Light-Emitting Diodes

Light means progress: the incandescent light bulb, once the pioneer of a global lighting revolution, is disappearing from stores. It has long been superseded by a new generation of light sources. In tomorrow's multimedia society, color displays the size of a house will generate crystal-clear images and entire sports stadiums will be lit by high-performance lamps. But light can also be used as a tool – laser scalpels have become an indispensable part of medical technology. These new lighting technologies are driven by energy-efficient light-emitting diodes, or LEDs. WACKER's researchers have now developed an innovative UV-curing silicone that makes it relatively inexpensive to manufacture the energy-saving light sources of the future.

The future of light

Nothing travels faster than light. Both the internet and telephones rely on light waves. Fiber-optic cables transmit light pulses around the globe at incredible speeds. But the last ten years have seen not only a proliferation of data transfer, new visualization possibilities have become established. Information is universally available on cell phone displays, and books are becoming e-books.

These technologies are exceptionally efficient thanks to energy-saving backlighting by light emitting diodes (LEDs). “High energy efficiency, a great color range, stability, long life, brilliance and completely new design options are what make light-emitting diodes appealing for all lighting applications,” says Dr. Klaus Angermaier, Senior Marketing Manager Transportation & Energy at WACKER. LEDs are shedding a whole new light on the market.

The days of the incandescent lamp are numbered

The good old incandescent lamp has finally had its day. Since September 1, it has been forbidden to sell 100 watt incandescent bulbs in the EU, and lower wattages are to be phased out by 2012. According to the Photonik 2020 initiative, about 8 billion incandescent bulbs will need to be replaced around the world eventually.

Various lamp types are available as replacements, including improved incandescent and halogen lamps, as well as energy-saving (compact fluorescent, CFL) lamps. LED technology is particularly attractive because of its high light yield, which is doubling roughly every three years. A conventional LED has achieved about 50 lumens per watt so far. But it is likely that this will be increased fourfold in the near future.

This compares with an incandescent bulb, which only manages 12 lumens per watt. However, despite being so inefficient, it is still the preferred light source in German households. Incandescent bulbs produce so much heat that you can burn your fingers on them. Only five percent of the energy they consume is

actually converted into light.

LEDs are more economical than fluorescent tubes and last longer

Exchanging them for more efficient light sources can save a good deal of energy. Experts estimate that private households in Germany could save up to €2 billion per year. “The EU expects that, in Germany alone, merely replacing incandescent with energy-saving lamps will save 7.5 billion kilowatt hours in private households. Replacing these with LEDs will save even more,” says Professor Norbert Huttenhölscher, director of EnergieAgentur NRW. “The energy saving for televisions with LED lighting can be as much as 50 percent,” says Bernd Franke, head of strategy and information at the VDE Institute. “Compared to fluorescent tubes, LEDs save up to 60 percent energy and for much longer lifetimes,” continues the expert.

LEDs will provide the street lighting of the future

At first, LEDs will take over our roads, where there is a particularly urgent need for renovation. “According to estimates by the German Electrical Luminaires and Electrical Lamps Trade Associations[1], for example, 50 percent of German cities still use street lighting based on 1960s technology,” Hüttenhölscher explains.

“Climate Protection Technologies,“ an initiative by the German Federal Environment Ministry, subsidizes the modernization of municipal street lighting. Only three percent of these “vintage lights” are replaced annually. Nationwide savings are estimated at 2.7 billion kilowatt hours, or some 400 million euros,”

[1] The German trade associations Electrical Luminaires and Electrical Lamps have been replaced by the joint trade association „Light“ in September 2009. For details, see www.zvei.org.

according to Hüttenhölscher. Professor Tran Quoc Khanh of the Lighting department at Darmstadt Technical University has no doubts either: “The street lamp of the future is the LED lamp. The potential for savings is huge.”

Silicones resist light and heat

But as LED performance increases, the materials used – such as the lenses – must meet new challenges. The materials that have been used up to now can yellow under intense light fluxes. In future, therefore, silicone will be preferred for modern high-performance LEDs: “Silicone elastomers have the necessary heat and light stability,” explains Dr. Philipp Müller, an applications engineer at WACKER in Burghausen.

New material blend bonds well and does not cloud the lens

With a new optical high-performance silicone, marketed under the trade name LUMISIL®, optical lenses for LEDs are produced directly on the light-emitting diode chip (see box below). This method is particularly efficient and reduces the traditionally high production costs. “Up until now, LED manufacturers had been using a complex injection molding process to make the silicone lenses. With our product they can eliminate about five process steps,” explains Müller.

The novel silicone is applied by conventional dosing to produce the optical element, which is then flash cured by exposure to UV light. WACKER’s chemists came up with a material blend that was suitable for this step and also provided optimum adhesion. Says Müller, “The silicone has to bond equally well to both metal and plastic and must not cloud the LED lens.”

Proven and tested: LEDs last for about 50,000 hours …

The new LED material has proven itself in practical trials: “One of the world’s leading LED manufacturers has been convinced by LUMISIL®, with its outstanding transparency, excellent mechanical strength and long-term resistance to extreme UV exposure,” says Müller. The bright LEDs are simply unbeatable for use as spots and light-emitting surfaces: energy-saving lamps have lifetimes of about 6,000 to 15,000 hours, but LEDs as much as 50,000 hours. Analysts from iSuppli predict that by 2025 one in every three light sources will be an LED.

… and reduce carbon emissions significantly

The diodes don’t just make sense financially. They also protect the climate. Professor Khanh of the Laboratory of Lighting Technology at Darmstadt Technical University believes that with today’s technology alone, Germany could cut its carbon emissions by 1.6 million metric tons per year. This translates to annual savings of 400 million euros. In global terms, current LEDs could cut the world’s energy demand by around 30 percent. Almost a fifth is still consumed for lighting. Technical advances could slash that by a further 30 percent, say industry experts. That would save up to 650 million metric tons of CO_2.

LEDs make driving safer and help reduce fuel consumption

LEDs have been present in cars for a while now. Here, too, their energy saving properties are much appreciated. The low power consumption of the diodes significantly reduces fuel consumption. In Germany alone, this results in fuel savings of several million liters a year. In the Audi R8, they are already used in the main and dipped headlights, position lights and blinkers. LED lights have addition benefits for drivers. At night, the road and curb appear in natural colors and the human eye can distinguish

the contrasts better. LED systems also enable intelligent lighting control, in which the intensity is adjusted according to weather and traffic conditions.

LEDs create a whole new range of lighting possibilities

LEDs will not only earn an established place in cars. The technology is so versatile, that novel lighting and illumination solutions are now within reach. LEDs allow more flexible control of color shades, giving lighting designers a whole new range of creative possibilities.

A glowing future

It is only a question of time until LEDs become an established part of our everyday lives. Silicones from WACKER will play an important role in this. “With them, we can also serve major markets like the USA and Japan,” says Dr. Bernd Pachaly, head of the Elastomers Business Unit at WACKER. The silicones manager is therefore optimistic, “We are expecting annual growth rates of 20% in LEDs.”

Background Information on Silicone Elastomers

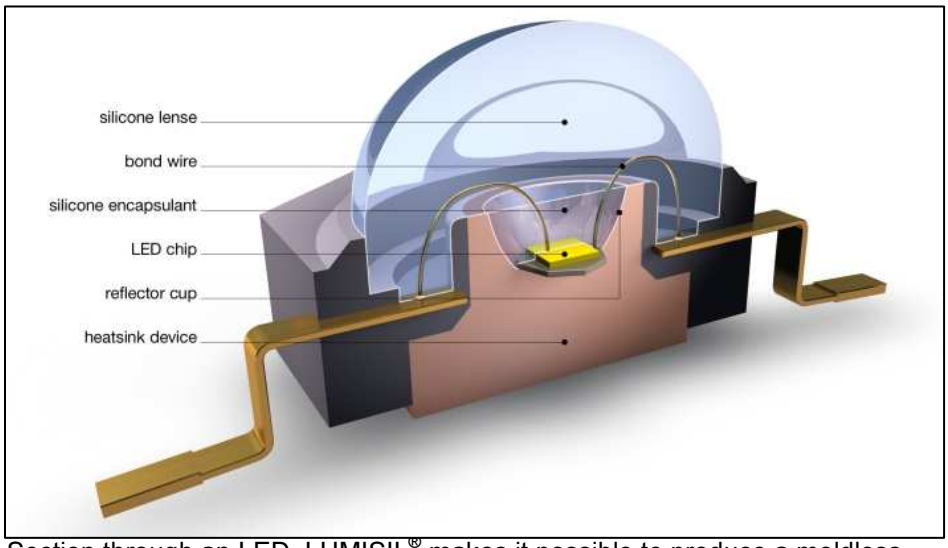
LUMISIL® UV

WACKER manufactures a wide range of addition-curing silicone elastomers with a wide bandwidth of mechanical and rheological properties. These silicone elastomers cure either at room temperature or when heated in an oven, for example. LUMISIL® UV is different. It is cured not by heat but by brief exposure to ultraviolet (UV) light. Unlike other systems, LUMISIL® UV does not release byproducts when it cures.

LUMISIL® UV enables a moldless optical lens to be produced directly on an LED chip, using a dispensing process in a single production step. LUMISIL® 419 UV offers an additional benefit. Its excellent adhesion even makes it possible to forgo the use of a silicone encapsulant, since, in addition to providing the lens material, it also protects the LED chip. In this manner, LED components with silicone lenses can now be manufactured in very large quantities with comparatively modest plant and process investment.

WACKER's new optical high-performance silicone brand LUMISIL® enables optical lenses for LEDs to be produced directly on the light-emitting diode chip. The process is highly efficient and cuts the traditionally high cost of LED production.

(photo: Wacker Chemie AG)



Section through an LED. LUMISIL® makes it possible to produce a moldless optical lens directly on an LED chip, using a dispensing process in a single production step. In this manner, LED components with silicone lenses can now be manufactured in very large quantities with comparatively modest plant and process investment. (Graphic: Wacker Chemie AG)

Note:
These photos are available for download at
http://www.wacker.com/presseinformationen

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The company in brief:
WACKER is a globally active chemical company with some 15,900 employees and annual sales of around €4.3 billion (2008).
WACKER has 27 production sites and over 100 sales offices worldwide.

WACKER SILICONES
Silicone fluids, emulsions, rubber and resins; silanes; pyrogenic silicas; thermoplastic silicone elastomers

WACKER POLYMERS
Polyvinyl acetate and vinyl acetate copolymers in the form of dispersible polymer powders, dispersions and solid resins used as binders for construction chemicals, coatings, adhesives, paints, plasters and nonwovens

WACKER FINE CHEMICALS
Fine chemicals, biologics and other biotech products such as cyclodextrins and cysteine

WACKER POLYSILICON
Polysilicon for the semiconductor and photovoltaics industries

Siltronic
Hyperpure silicon wafers and monocrystals for semiconductor devices