Issue 01 | 2007/2008

THE QUINTESSENCE of LED Technology

The Knowledge Magazine from EBV Elektronik

Unstoppable growth in the LED market

The introduction of the colour white alongside the array of red, orange, yellow and green high-power LEDs in 1997 marked the start of an entirely new lighting market – Solid State Lighting (SSL).

As far back as 2001, studies by British market researcher iSuppli put the global market in standard and high-brightness LEDs at around 2.5 billion dollars. Two years later, ultra-high-brightness LEDs also came along. Since then the market has seen annual growth rates of around 16 per cent, and today is worth some six billion dollars.

Increased light output, a wider colour palette, energy efficiency and a completely new awareness of light in industry and private households promise further growth. According to iSuppli, the market in LED technology will break through the nine billion dollar barrier by 2011.

With almost 40 years experience in semiconductor distribution and annual sales of over 1.3 billion Euro, we know the electronics market better than anyone. It was clear to us years ago that LEDs would revolutionise the lighting market. We made preparations to go with that trend at an early stage, establishing our own dedicated General Lighting competence team. The team supports our customers in putting their lighting ideas into practice – ranging from general lighting and illuminated house facades, through automotive LED applications, to ambient lighting solutions for restaurants, hotels and wellness facilities. We provide this service to our customers in line with our full-solution philosophy at the same high level whether in Dublin or Dubai, Copenhagen or Cape Town.

I wish you every success in your use of LED designs from EBV!

Slobodan Puljarevic
President & CEO, EBV Elektronik

Editorial

Dear Reader,

*An **LED** (light-emitting diode) is an electronic semiconductor component. When current flows through the diode it emits light, infrared or ultraviolet radiation.* That is more or less the official description. It conceals a great deal more know-how and remarkable technology however.

LEDs and a wide range of other exciting new topics inspired us to develop a new magazine series: "The Quintessence". Each issue will be devoted to a specific topic, produced in collaboration with independent specialist authors and technical experts. "The Quintessence" is not a marketing tool for the purposes of product promotion, but a magazine aimed at disseminating knowledge.

Our intention is to provide the latest news and information on all hot topics and technologies in an independent and comprehensive manner.

This first issue of our new magazine tells you all you want to know about the special features of LED technology. Highlights of the first issue include applications demonstrating the design scope offered by LEDs, such as the impressive lighting concept for the Torre Agbar in Barcelona and the fascinating use of LEDs by light designer Ingo Maurer. The article about our round table discussion with leading lighting experts provides an insight into ongoing developments in LED technology.

And here's the key: "The Quintessence" is intended for you – our readers and customers!

Help us to make it a success! We look forward to receiving any feedback, queries or suggestions for future topics you may have. Please email me at: bernd.schlemmer@ebv.com.

Best regards,

Bernd Schlemmer
Director Communications, EBV Elektronik

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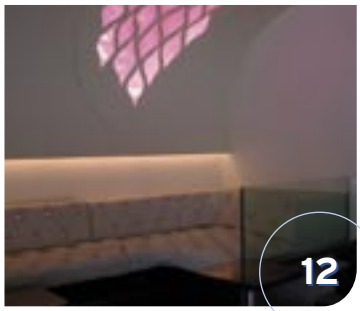

What makes LEDs so special

Technical terms from the world of LEDs

The lighting concept for Barcelona's innovative office building

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Areas where LEDs have become indispensable

What lighting experts think about the future of LEDs

Insight into the creations of a famous lighting designer

Light – the source of life

LED light can make plants grow. LEDs are even used by the NASA Commercial Space Center to grow plants in space.

When a person is born, there is a saying that he or she "first sees the light of the world". But at such times no one is really thinking about the fact that we do indeed owe our very existence to light. Sunlight gives warmth, enables plants to grow, controls the interchange of day and night, the seasons, and our own body clocks. It not only allows us to see, but also dictates our moods by its influence on our hormone balance. Low sunlight in winter, for example, causes some of us to suffer from a form of depression known as seasonal affective disorder (SAD). The cause of such disorders is a lack of vitamin D, which our bodies can only produce from cholesterol if we have sufficient sunlight. But what exactly lies behind this fundamental source of energy for life?

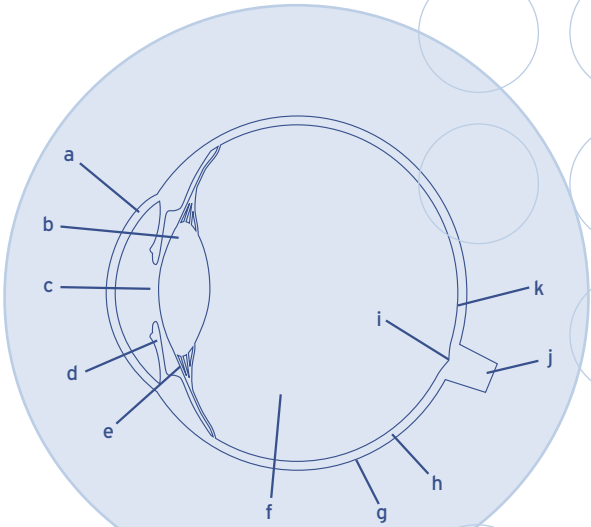
The difference is in the wavelength

Light is visible electromagnetic radiation emitted in waves by a light source. Light waves differ from other forms of electromagnetic radiation, such as radio or radar, only in their wavelength. Waves visible to us have lengths of between 380 nm (violet light) and 780 nm (red light), and are propagated at a speed of 300,000 km/s. Every *spectral colour* in the visible band has a specific wavelength. Light with the same wavelength cancels itself out if the phase angles are in opposition, while the interaction of all colours in the spectrum produces white light. Colours, or coloured objects, can only be perceived in colour if the light source contains the corresponding spectral colours. If the spectral colours red, blue and green are missing from the light emitted by *low-pressure sodium vapour lamps*, for example, the objects they shine upon will appear in a yellow light. All spectral colours occur in the sun, for example, or in incandescent and fluorescent lamps.

Invisible but perceptible

Bands above and below visible light are infrared (IR) and ultraviolet (UV) light. When IR radiation, with its wavelength of between 780 nm and 950 nm, strikes an object it is absorbed and converted into heat. UV radiation is divided into three sub-bands according to its biological effect on organic matter, which may be either positive or negative: UV-A (315 to 380 nm), which tans the skin; UV-B (280 to 315 nm), which reddens the skin or causes sunburn; and UV-C (100 to 280 nm), which destroys cells, and is used in bactericidal lamps for targeted disinfection. It is not just the skin which perceives light of course, but primarily the eyes.

The eyes – light receivers



The eye:

Just a few highly sensitive components interact to create a precision vision instrument: a Cornea | b Lens | c Pupil | d Iris | e Ciliary muscle | f Vitreous humour | g Sclera | h Retina | i Blind spot | j Optic nerve | k Fovea

Human beings perceive the world around them by way of their senses. The most important of all the senses is eyesight, as the eyes receive around 80 per cent of all the information we take in from our surroundings – though only if light is present. The optical part of the eye comprises the cornea, the lens, and the aqueous humour inbetween. In front of the lens is the iris, with its variable central opening – the pupil.

The inner part of the eye is filled with a transparent clear mass called the vitreous humour. The retina on the inner wall of the eye carries some 130 million optical cells – the cone and rod retinal receptors. The small recess in the retina – the fovea – is the point of sharpest focus, as it is where the optical cells are arranged particularly densely to view daylight and colour. Approximately 120 million rod receptors are responsible for light sensitivity. Since their maximum spectral sensitivity is 507 nm (blue-green), they are relatively insensitive for colour viewing. Detection of the three basic colours red, green and blue is the job of the approximately 7 million cone receptors. Their total maximum spectral sensitivity is 555 nm (yellow-green). As those three basic colours together create a colour impression, there are three types of cone, each with a different spectral sensitivity.

Precisely metered light flux

In order to see objects at different distances in focus, the curvature of the refracting surfaces of the eye lens can be varied. This is termed accommodation. The adjustment of the eye to different levels of brightness is termed adaption. The more light strikes the eye, the smaller the pupil opening becomes. Where there is a small amount of light the pupil responds in the opposite way – widening in order to enlarge the inflowing *light flux*. Quality of vision depends on the adaption of the eye in question, and improves as the *lighting level* increases. Consequently, an eye takes around 30 minutes to adjust from the lighting level of a brightly lit room to night-time darkness outside. In contrast, it takes just a few seconds to adapt from darkness to bright light.

Sensitivity to shape and focus of vision are key to identifying detail. As well as the level of adaption, focus also depends on the resolving capacity of the retina and on the quality of optical imaging. For flawless vision, four conditions must be met: there must be a minimum light density; the object must have a contrast in brightness relative to its surroundings; the object must be of a minimum size; and finally, a minimum time is required for visual perception. Consequently, some of these criteria need to be taken into account when planning lighting. Changes in brightness must take place slowly. This is achieved most easily by infinitely adjustable *dimming*. A shadow thrown by the direction of the light is essential for contrast. So the position of the light source is not a trivial factor. In early times people were unaware of the negative effect of poor lighting on our body's systems. It was important for just them to see – whether well or poorly.

Lighting standard

In order for the quality of light and lighting to conform to the demands of its ergonomic function at the workplace and have the desired beneficial health effects, the centralised lighting standard *DIN 5035*, "Lighting by artificial light", was introduced in Germany. It is based on research into the physical optical properties of vision and on findings in workplace ergonomics over a period of more than 50 years.