LITEC-LLL GmbH
Leuchtstoffe - Lampen - Lichttechnik

Application Guidelines

Company's profile

The brand LITEC is well known for high quality phosphor products for LED and lamp application.

Business started in June, 1994, when LITEC-LLL GbR was established by Dozent Dr. rer. nat. habil. Walter Tews and Dr. rer. nat. Gundula Roth from the Institute of Physical Chemistry at Greifswald University. The company selected the West Pomerania Technology Center in the Technology Park of the university and Hanseatic town of Greifswald as its place of business.

The continued success of the company's research and development activities is reflected by a variety of phosphor and applications patents for lamps and LED, and, finally, a production plant for innovative phosphors was set up.

LITEC-LLL GmbH was established in 2002.

Today, LITEC-LLL GmbH is a modern, independent production, research and development company with numerous national and international partners and customers and primarily specializes in the development, production and marketing of high-quality custom phosphors.

Our main areas of activity are:

1) Production of high-quality, customer specific phosphors for LEDs
2) Research and development in the field of phosphors
   a) Phosphors for LED applications (based on UV and blue chips)
   b) Phosphors for medical applications
   c) Development and improvement of phosphor mixtures
3) Research and development of phosphors for application in any lighting products.

In January 2008, LITEC-LLL GmbH has been awarded the Certificate under "DIN ISO 9001:2000".

Location of LITEC-LLL

LITEC has selected the Technology Center in Greifswald as its place of business.

In the North-East of Germany, LITEC's head-office inside the Technology Center of The city of Greifswald, LITEC's production plant with modern production and analytical equipment.

Litec-LLL GmbH in the West Pomerania Technology Center in the Technology Park of the university and Hanseatic town of Greifswald.

Application information and general procedures

1) For all BOSE phosphors, there exists no defined amount of phosphor which has to be used in white LED for reaching a special color point.
2) The amount depends strongly on LED wavelength and the kind of package.
3) The addition of light scattering material (e.g. Silica or Alumina) can be recommended.

General procedure

1) Phosphor: BOSE phosphors from LITEC-LLL can be applied in all known LED and package types.
2) Resin: Epoxy based polymers, acid free silicones or other polymeric pastes can be used. The handling should follow the instructions of the resin manufacturer.
3) Phosphor selection: Depending on LED chip wavelength and the target color coordination the suitable phosphor has to be selected.
4) Phosphor concentration: Before using BOSE-phosphors in LED, tests should be done by the preparation of 5-10 LED with 3-5 different phosphor concentrations (e.g. 10%, 15%, 20%, and 25%) in the resin. After calculating color coordinates, probably a refinement to find out the right phosphor concentration has to follow. Once, the right ration between phosphor and resin for a package is found it can be applied further. The table below shows a short overview about concentration ranges for top and side view LED of different chip wavelengths to reach CIE coordinate x=0.30, y=0.30. The procedure is similar for all other LED designs.
5) Mixing and degassing: The phosphor and resin should be mixed well and stored for at least 20 minutes in vacuum to remove air bubbles.
6) Curing: After filling the LED packages, LED should be placed into a heating unit under conditions the resin manufacturer describes for the polymer (e.g. 5 hours at 150°C). The BOSE phosphor will be stable under all possible curing conditions.
7) For color on demand LED (paste light), simulations or experiments with chip-spectrum and phosphors has to be done to match the target CIE point.

BOSE-Phosphors from LITEC-LLL GmbH based on the General Formula: (Sr,Ba,Ca)2-xSiO4:Eux

1) All phosphors from LITEC are mass products with a stable product quality within only small tolerances.
2) All phosphors from LITEC are excitable by blue and ultra violet light from any light sources (LED, low pressure mercury lamps, a.o.).
3) All phosphors from LITEC can be used as conversion materials for blue or UV-LED to produce white light or color on demand.

4) All white targets (2000-8000 K) can be realized by using BOSE phosphors from LITEC-LLL.
5) Color triangle with some LITEC-LLL phosphors (for blue and UV-LED) and LED locations. All color points inside the greyish area (2000-8000 K) are reachable with BOSE phosphors from LITEC-LLL.
6) Green and orange BOSE phosphors can be used for white LED with higher C.R.I. and LED showing color on demand.
7) Emission spectra of BOSE-Phosphors showing the wavelength range of the emission maximum from deep green to deep orange.
8) Dashed lines show the excitability of a green, a yellow and an orange BOSE phosphor.
9) Orange phosphors are excitable until 520 nm, yellow phosphors until 500 nm and green phosphors until 470.

Particle size distribution

The particle size distribution of BOSE phosphors is adjustable depending of customer's requirements. Some microscopic pictures (1200x incident illumination) and SEM investigations will show the possibilities we are able to produce.

Over time phosphor particles tend to settle within encapsulating materials (silicone or epoxy), resulting in a change of concentration in the dispensing syringes and consequently in the LEDs. The sedimentation takes place at two steps of the packaging process: a) in the syringe of the dispensing process, and b) in the LED packaging lead-frame before the epoxy or silicone is cured. Such sedimentation results in a large range of CIE in the LEDs produced.

Decreasing the size of the phosphor particles can significantly reduce the sedimentation problem. However, normally with the decrease of particle size, the conversion efficiency of the phosphors will also be reduced. Typically, reducing the D50 (V) of silicate phosphors from 20µm to 10µm will result in an efficiency decrease of around 10%. Litec' latest product with D50 (V) ~15µm maintains high emission efficiency.

Other approaches to alleviate the sedimentation effect include: a) using epoxy or silicone with higher viscosity; b) using silicone or epoxy that cures faster; c) using dispersant in the encapsulation materials; and/or d) reducing the time between filling the syringe and dispensing into the LED packages.

Technical Delivery and Phosphor Storage Information

Phosphor Types: (Sr,Ba,Ca) 2-xSiO4:Eux

General

This general information applies to BOSE phosphors having the general chemical formula above, supplied by LITEC-LLL GmbH, Germany.

LED Chip Selection

Litec phosphors are oxide-based materials. They can be excited by a wide range of light wavelengths, from UV to the near starting edge of the phosphor emission wavelength. For Litec yellow and green phosphors, the efficiency increases with decreasing excitation wavelength. A similar trend is observed for the orange and red phosphors, with the strong absorption and excitation at green wavelengths (see the specifications of each phosphor). Although LED chip and phosphor selection involves the consideration of a number of factors the following criteria are the factors, most relevant.

Phosphor Selection

Litec offers a variety of phosphors ranging from blue, green, yellow, to orange and red. Similar to the selection of LED chips, phosphors should be selected based on the LED products' specifications. Phosphors of the same family, such as the yellow series, can be mixed in order to fine tune the final CIE.

Phosphors of different families can also be mixed, but please pay attention to the secondary absorption between different phosphors. For example, when mixing an orange and green phosphor, the strong absorption of the orange phosphor at the green wavelength will significantly distort the balance of orange and green light emitted.

Hence, the orange portion of the spectrum will appear to be much stronger than expected from the concentration ratio of the orange and green phosphors.

Encapsulation Materials

Silicone and epoxy are commonly used as encapsulating materials. Silicones commonly used in the market are manufactured by Dow Corning, GE, Loctite etc. RTV615A and RTV615B made by GE with an A: B = 10:1 are commonly used in Litec' internal tests. The mixture of phosphor and silicone is placed under vacuum in a vacuum chamber to eliminate air bubbles.

Silicone has better reliability, a higher refractive index and better thermal conduction than epoxy. Additionally, it can be cured faster than epoxy which will prevent the settling of phosphor in the holding cup. It is also important to select a proper viscosity to reduce the sedimentation rate of phosphor in the injection syringe without creating dispensing difficulties.

Phosphor Concentration

The required phosphor concentration depends on the packaging type. The following tables provide guidelines for phosphor concentration in different packages. Optimization of these suggested concentrations will be necessary to achieve exact requirements due to packaging variations and CIE targets.

Optical properties

Silicate Phosphor: Europium (II) is very efficient green, yellow or orange emitting fluorescent powders for special fluorescent lamps or LED. Excitation takes place mainly by 254 nm or long-wave ultraviolet radiation as well as blue light. The brightness is related to a standard for each phosphor said above. Chromaticity coordinates as well as the particle size distributions are defined in the specifications for each said phosphor type.

Packing

Said phosphors are usually packed into Ethylene bottles in the unit of 0.5 to 5 kg and are well closed for keeping out moisture and other impurities. The bottles have outside a LOT-label and a short instruction label.

Label

Label colors follow the body color of said phosphors (*e.g. yellow for 560 to 580nm emission maximum*).

Labels include: Name of phosphor (*e.g. FA565*)

Lot-number (*e.g. FA565-30-05*)

Quantity (*e.g. 500 g*)

Date of packing (*YYYY-MM-DD*)

Manufacturer (*LITEC-LLL GmbH*)

Storage

Bottles with phosphors should be closed well to keep out moisture, dust or other impurities. Originally closed bottles should be stored in a cold and dry place (humidity 60% or less, T less than 35°C).

Avoid contact of phosphor with acids and/or water in order to degradation of phosphor. Opened bottles should immediately be closed well after using and stored in desiccators to avoid contact with moisture.

Warranty

For all originally closed products LITEC-LLL GmbH guarantees a stable quality under proper storing conditions for a period of 1 year from the date of delivery.

The quality of the products will be stable for years while properly closed and stored.

How to use BOSE in LED

For all BOSE phosphors, the amount of phosphor which should be used in LED for reaching a special color point depends strongly on LED wavelength, the package design and the resin. Therefore, before using BOSE-phosphors in LED, tests have to be done. As resin common epoxy, absolutely acid free silicones or other polymeric pastes can be applied.

Attached Documents

For each delivery following documents are enclosed for each Phosphor type delivered:

1) Emission spectrum at 430 nm (for 508 nm to 555 nm type) or 450 nm (for all other BOSE phosphors) excitation wavelength
2) Particle size distribution with D10, D50 and D90
3) Certificate of conformance
4) Specification with defined values for phosphor properties

Description of LITEC-LLL phosphors

General remarks for all BOSE phosphors from LITEC-LLL.

Crystal structure: orthorhombic

Space group 62 (pmnb) / FA508 – FA593

Space group 33 (pna21) / FA1320 – FA2165

***Color coordinates*:** Color coordinates are calculated from spectra at blue light excitation. Samples from FA560 to deep orange are usually measured at 450nm and samples from deep green to FA555 are measured at 430nm excitation wavelength for calculating color coordinates. Data for x and y are given within small tolerances of ± 0.001.

Particle size distribution: The particle size distribution is adjustable to customer's requirements. Given data will show the most common ranges. A particle size distribution is given as an example.

Emission / Excitability: All BOSE phosphors are excitable by ultra violet and blue light. Excitation spectra are given beside emission spectra for each type of BOSE phosphor.

LED Brightness and color rendering: The highest brightness will be maintained by using only a single phosphor to generate white light, which will show low C.R.I.values. LED showing higher C.R.I. values will show lower brightness. The definition of final application will choose the right phosphor or combination.

Patent protection: The use of all LITEC BOSE phosphors in a LED is protected by some granted patents.

LEGAL

LITEC-LLL GmbH's internet presence is managed from Greifswald, Germany.
By visiting LITEC-LLL GmbH's web pages user agrees to the applicability of the laws of the Federal Republic of Germany, excluding private international law, in the event of any legal dispute related to the contents of LITEC-LLL GmbH's web pages.
Any legal dispute shall be settled in the competent German court of law that has jurisdiction over LITEC-LLL GmbH's place of business.

Comparison With Other Phosphors

a) Brightness comparison: Brightness depends on the CIE value due to color correction and eye sensitivity; therefore, the brightness of white LEDs must be compared at the same CIE value for different phosphors. In the case of warm white LEDs, a comparison of the brightness should also consider the color rendering index (CRI).
b) Concentration and quantity used: The necessary quantity and concentration of Litec phosphor is normally slightly higher than that of SBCOSE phosphor in the LED packaging.
c) Excitation range: The best excitation wavelength range for SBCOSE is 450-460nm. Although Litec yellow phosphors may have a slightly lower efficiency in this excitation range, they offer significantly higher efficiency as the excitation wavelength is decreased to the range of 450-460nm, even as the excitation moves deep into the UV region.

Litec is committed to supporting our customers as they make the best use of our phosphors. For assistance using our products, please contact Dr. Marlon in sales director, Email: marlon@litec-lll.de or Tel.: +49 (0)3834 - 5501417.

Services

1) Production of customer specific phosphors for LEDs
2) Customer specific research and development:
    a) We accept long and short term research commissions in the field of phosphors and their application in any lighting products. In the course of many years of cooperation based on customer specific research for the industry - both pure and applied research - we have already provided relevant patented solutions.
    b) We adapt LITEC-LLL GmbH's phosphors and phosphor products according to our customers' specifications and requests.
3) Consultancy services and expert opinions concerning lamps, phosphors and lighting engineering.
4) Measurement of optical and luminescent properties, and other measuring services.

Our staffs contribute expert, interdisciplinary know-how in the areas of solid-state chemistry, physical chemistry, and plasma physics. Their activities in further specialist fields such as technical chemistry, analytical chemistry, spectroscopy, photochemistry, chemistry of phosphors, and organic chemistry enable us to cover a vast range of requirements.

Contact

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