1. Phosphor converted Xe DBD lamps

Dielectric barrier Xenon excimer discharge lamps are known as efficient sources of vacuum ultraviolet radiation, while the main band peaks at 172 nm. By the use of VUV excitable conversion materials which are applied as a coating layer onto the lamp body it is feasible to manufacture efficient UV-C, near UV, or even UV-A/B emitting Xe excimer lamps which may perform well for the replacement of established Hg discharge lamps and respective UV radiation systems.

2. UV emitting LnPO4:X phosphors for Xe DBD lamps – effective disinfection

Optical grade YPO4, LuPO4 and LaPO4 were aged analogous to the doped phosphor materials. All analysed orthophosphates exhibit comparable aging effects indicated by characteristic photoluminescence spectra. Solid State NMR reveals that the bulk host material remains unaltered (within the detection limits). The uprising absorption band may be accompanied by a general increase of photoluminescence, a consequence of the observed degradation and decreased excitation efficiency.

3. Device lifetime limitations: aging effects on LnPO4 based phosphor materials within an Xe excimer discharge

Phosphor converted Xe excimer lamps comprising YPO4:Bi (internal phosphor) exhibit a distinct and fast characteristic aging under continuous operation:

- Observable greying of the actually clear white phosphor coating
- Continuous decrease of UV radiation output over operation time (after 24 h foreseen)
- A dimming of 30 % (L70) is already reached after ~230 hours run-time

Spectroscopy of aged YPO4 and YPO4 doped with Bi3+, Pr3+ and Gd3+, respectively reveals:

- The distinct aging effect is evident regardless the dopant cation and is as well observed for the undoped host material YPO4.
- As a detectable main symptom of aging, a novel broad emission band appears rising from the visible beginning at around 500 - 600 nm towards the UV region.
- The uprising absorption band may be accompanied by a general overall absorption (greying) and an absorption band ascribed to a reduced activator species in case of YPO4:Bi (Bi5+ + Bi3+)
- Upon PL excitation into the new host absorption bands in the UV yields deep red luminescence, regardless which or any doping. This phenomenon was further followed by the temperature dependent PL spectra of aged undoped YPO4, LaPO4 and LuPO4 (see B).

4. Device lifetime improvement: Application and impact of protective inert particle coatings

Particle Coating: Ideally, each and every single phosphor particle is coated with an homogenous and surface covering coating of a Al2O3 to prevent phosphor aging (degradation) under exposure to the Xe discharge. An optimal coating quality in terms of homogeneity and particle surface coverage were yielded with a photochemically driven precipitation process, recently described in literature.

For further information look up literature 4 or follow

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Literature


Fig. 1: Xe-DBD lamp operated in air

Fig. 2: Schematic illustration of the principle of operation of two different phosphor converted Xe excimer DBD lamp types.

Fig. 3: VUV-excitation-, emission and reflectance spectra of the UV-C emitting phosphors YPO4:Bi and YPO4:Pr and the VUV-Emitting Phosphor YPO4:Nd, respectively

Fig. 4: Relative photocatalytic disinfection efficacy for Escheria Coli according DIN 5011-10

Fig. 5: a) UV-C output vs run-time for a YPO4:Bi comprising Xe lamp. b) Excitation, emission and reflectance spectra of aged and untreated YPO4:Bi, respectively

Fig. 6: Excitation, emission and reflectance spectra of aged and untreated YPO4:Pr, YPO4:Gd

Fig. 7: Temp. dependent excitation and emission spectra measured from aged samples of YPO4, LuPO4 and LaPO4.

Fig. 8: Solid state 31P NMR measured for aged and untreated YPO4 (left) and aged and untreated LaPO4 (right).

Fig. 9: Xenotime structure

Fig. 10: Monazite structure

Fig. 11: a) Energy level scheme for ns2 luminescence; Middle: Temp. dependent excitation and emission spectra measured from aged YPO4, LuPO4 and LaPO4.

Fig. 12: a) Energy level scheme for ns2 luminescence; Middle: Temp. dependent excitation and emission spectra measured from aged YPO4, LuPO4 and LaPO4.

Fig. 13: Illustration of UV driven particle coating process

Fig. 14: Top: UV-C output vs run-time for a YPO4:Bi and Al2O3 coated YPO4:Bi comprising Xe lamp. Bottom: Excitation, emission and reflectance spectra of the aged YPO4:Bi and Al2O3 coated YPO4:Bi after 700 hrs run-time.