HIGHLY REACTIVE RARE EARTH OXIDE POWDERS FOR MORE EFFICIENT LUMINESCENT MATERIALS

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ABSTRACT

The luminous efficacy of fluorescent lamps of the three band phosphor type (/80 type), is improved by improving the quantum yield of the green (CBT) and red (YOX) luminescent powders used in these lamps.
More reactive rare earth oxide powders, with improved morphology, and reduced level of impurities, have a major impact on the properties and preparation process of luminescent materials.

INTRODUCTION

The first objective of the "RELUM" project is to develop more reactive rare earth oxide powders with improved morphology and reduced level of impurities for more efficient luminescent materials.

The second objective is to use these improved rare earth oxides with improved morphology and reduced level of impurities for more efficient luminescent materials.

The second objective is to use these improved rare earth oxide powders to develop a process for the preparation of more efficient luminescent powders with narrower particle size distribution.

Luminescent powders for fluorescent lamps are synthesized in solid state reactions in which the starting, oxides or inorganic salts are mixed and 'heated at (high) temperatures below their melting point.

The reactivity and morphology of the starting materials have a major impact on the properties and preparation process of luminescent materials.

The proposed systematic" approach to the design tailored rare earth oxide powders will enable both European rare earth industry and European lighting industry to maintain and even strengthen their leading positions, on their respective world markets, particularly with regard to the Japanese and US competitors.

It might also lead to an acceleration of the replacement of incandescent lamps by (compact) fluorescent lamps and' thus to a considerable energy saving.

TECHNICAL DESCRIPTION

Several samples of pure and mixed rare earth oxides have been made as precursors for red (YOX) ana green (CBT, CAT) emitting phosphors.

The samples were prepared' from pure rare earth nitrate solutions. Purity was obtained by selective solvent extraction.

The general way of precipitation has been an oxalic precipitation followed by firing of the oxalate into the oxide.

Controlling the conditions of precipitation (tempera'ture, concentration) , filtration and drying; the size, shape and surface area were monitored.

A systematic evaluation of the effect of impurities and morphology in rare earth oxides on the luminescence of phosphors was made.

Samples were tested on a lab scale in phosphors and applicated in fluorescent lamps.

By using this knowledge it was possible to specify the optimal purity and morphology of the several rare earth oxides used in /80 phosphors.

Large batches of rare earth oxides were produced for the preparation of large scale production of phosphors.

Again these phosphors were applicated on a large scale in the production of tubular and compact fluorescent, lamps .

By' using mixed oxides instead of separate oxides, it was possible to change the preparation process of the phosphors.

As a result of the large scale application of these improved rare earth mixed oxides and improved preparation processes of both the precursor and the phosphor, more efficient luminescent powders with narrower particle size distribution, the luminous efficacy of fluorescence lamps has been significantly improved.

CONCLUSIONS

By improving the quantum yield of the red phosphor YOX and the green -phosphor CBT, an 'increase of 2.5% in luminous efficacy of */80 lamps was reached.

The luminous efficacy of YOX, for 254 nm excitation, is decreased, due to competitive absorption by impurities, c.q. transition metal ions and de'fects, like interstitial oxygen.

The green phosphors LAP and CBT are efficiently quenched by Eu^{3+}, due to an electron transfer process.

In CBT transition metal ions decrease the luminous efficiency of Ce^{3+}, Gd^{3+} and Tb^{3+}, since they are incorporated in the lattice, energy transfer to these impurity ions is possible.

An amorphous surface layer on a phosphor particle is observed with HR TEM.
It is concluded that Cr^{3+} is not incorporated into either LAP or CBT, but is present in an amorphous second layer.

By' changing process conditions during the production of the rare earth oxides it is possible to produce these starting materials with improved specifications

Using mixed oxides instead of separate oxides as starting materials the highest quantum yield was found.
Mixed oxides have an optimal distribution of the activator, so no' concentration quenching will occur on a micro scale.

By using mixed oxides in the production of phosphors the grainsize distribution has become narrower and better controled and so the coating weight was lowered in fluorescent lamps resulting in costprice reduction.

Both higher efficacy, (lm/W) and costprice 'reduction will lead to an acceleration of the replacement of incandescent lamps by (compact) fluorescent lamps and thus a considerable energy saving.

ACKNOWLEDGEMENT

The "RELUM" project was funded by the commission of the European Communities under the BRITE/EURAM programme, contract no. : BREU-147, Proposal no. : BE-3336-89.

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