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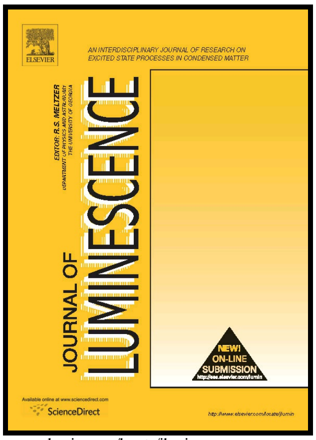

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An UV-C/B Emitting Xe Excimer Discharge Lamp Comprising $BaZrSi_3O_9$ – A Lamp Performance and Phosphor Degradation Analysis

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Abstract

This work concerns a highly efficient UV-C emitting phosphor, viz. $BaZrSi_3O_9$, which photoluminescence is suitable for a number of photochemical processes, e.g. for air, surface, or water disinfection as well as oxidative purification processes of water. The latter imply direct photolysis as well as photooxidation involving auxiliary components like H_2O_2. The material was investigated with respect to its application as a conversion layer in Xe excimer discharge lamps (λ_{Em} = 172 nm). To this end, substitution of Zr^{4+} by Hf^{4+} was performed aiming at an optimization of the preparative process and the resulting VUV conversion efficiency.

As-prepared powder samples were consecutively employed in state-of-the-art dielectric barrier Xe excimer discharge lamps and their performance was compared to $YPO_4:Bi^{3+}$ as a UV-C emitting commercially available reference material (Phillips GmbH). Even the non-optimized $BaZr_{0.8}Hf_{0.2}Si_3O_9$ succeeded the standard in terms of long term stability of its luminous flux. Detailed analysis of the material was secured by crystallographic as well as extensive optical and spectroscopic measurements. The latter was supplemented by EPR studies in order to further examine the underlying aging mechanism which governs the phosphor decay during Xe excimer lamp operation.

Keywords: Xe Excimer (DBD) Lamp, UV Emitting Phosphor, Lamp Lifetime Evaluation, Phosphor Degradation, Quantum Yield, Ozone Actinometry

1. Introduction

In a number of modern technologies photochemical techniques have already replaced classical chemical procedures due to their superior cost-effectiveness, environmental compliance, and flexibility.[1][2][3] Amongst them are low-temperature thin film deposition, photochemical thick film coatings, photopolymerisation and surface modification of polymers, waste water and drinking water treatments or disinfection of air, surfaces or water. In this work we focus on the material prerequisites of the latter two fields of application in which Xe excimer barrier discharge lamps have become an alternative to the widely used Hg low- or medium-pressure lamps or lasers.[4][5][6] This is primarily due to a number of inherent advantages related to the electronic setup and the generated radiation of these lamps.[7] In contrast to Hg discharge lamps, the primary VUV emission of the Xe excimer lamps (172 nm) is generated without involving the toxic element mercury which will most likely be banned from application within the next decades by the European Union.[8] Furthermore, Xe excimer lamps show a very fast run-up and the generated high energetic VUV