UV-Phosphors

Novel UV Emitting Phosphors for Gas Discharge Lamps

Rare Earth Elements and Compounds 2012

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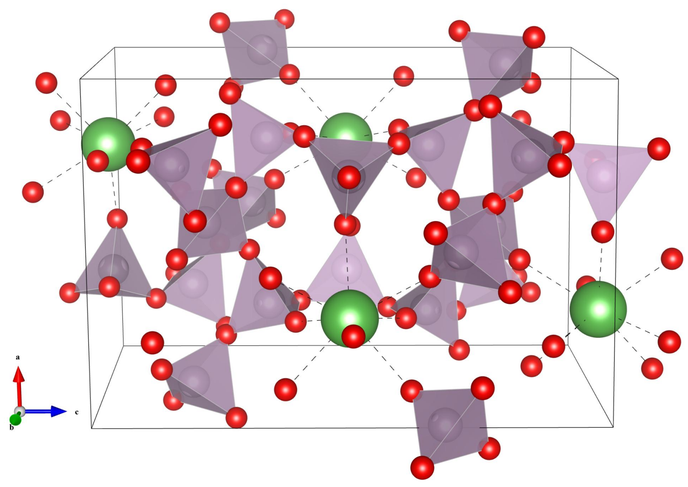
Introduction

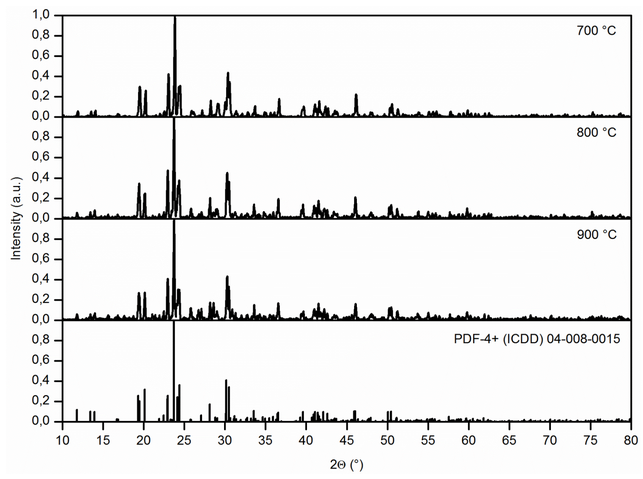
UV radiation is qualified for various technical applications. For example, UV radiation is well established in phototherapy. The range from 290 to 315 nm plays an important role for vitamin D production in human skin. Another wide field of application is purification of water with UVC radiation. Furthermore UVA lamps were recommended as light sources in photoluminescence liquid crystal displays. Generally the 253.7 nm emission of Hg low pressure lamps is converted to generate UV radiation of a certain wavelength, but also noble gas and halogen excimer lamps are often used light sources. Ortho-phosphates with various compositions are well investigated and widely known phosphors. To find a new UV emitting phosphor for radiation conversion in Hg or noble gas discharge lamps, the monoclinic ultraphosphate LaP_5O_{14} was doped with Rare Earth ions (Ce^{3+}, Pr^{3+}, Nd^{3+}, Gd^{3+}) or Bi^{3+}.

Crystallographic data of LaP_5O_{14}

LaP_5O_{14}	
Crystal system	Monoclinic
Space group	$P2_1/c$
Cell parameters	a = 8.8206 Å
	b = 9.1196 Å
	c = 13.1714 Å
	β = 90.661°



Unit cell of LaP_5O_{14}

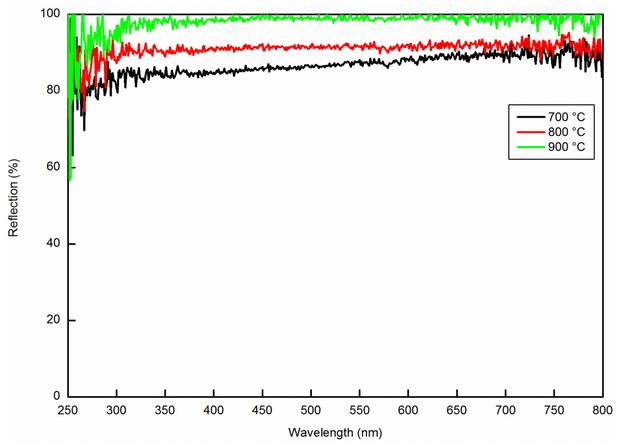


Diffraction patterns of LaP_5O_{14}

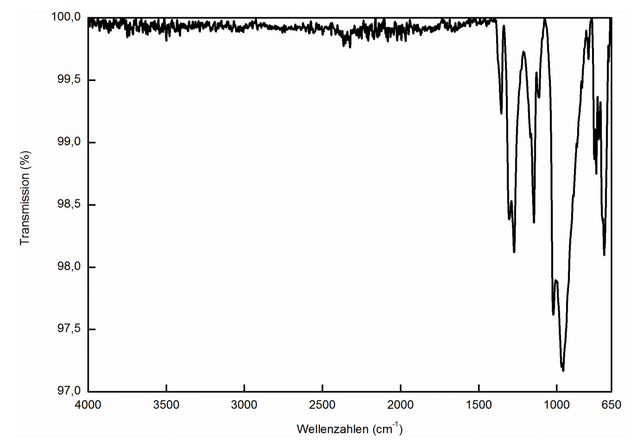
Synthesis

The phosphor samples were synthesized by conventional solid state using a La/P ratio of 1/10. The high purity starting materials were grinded in an agate mortar and calcinated subsequently in closed porcelain crucible at temperatures between 700 and 900 °C for 6 h.

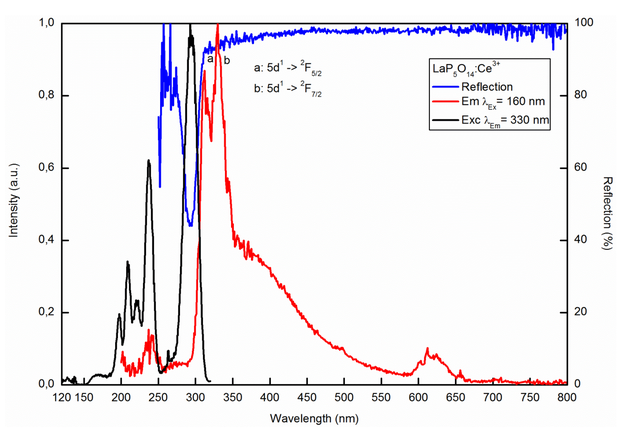
Phase purity was investigated by application of powder X-ray diffraction. Luminescence properties were characterized by VUV photoluminescence spectroscopy. Therefore, emission, excitation, and reflection spectra were recorded. The highest phonon frequency was determined by using ATR infrared spectroscopy.

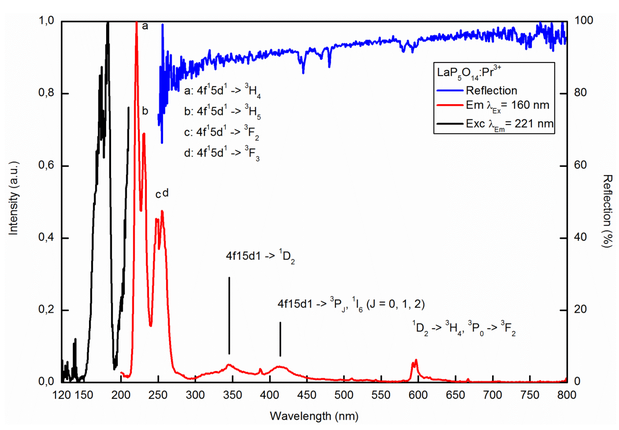


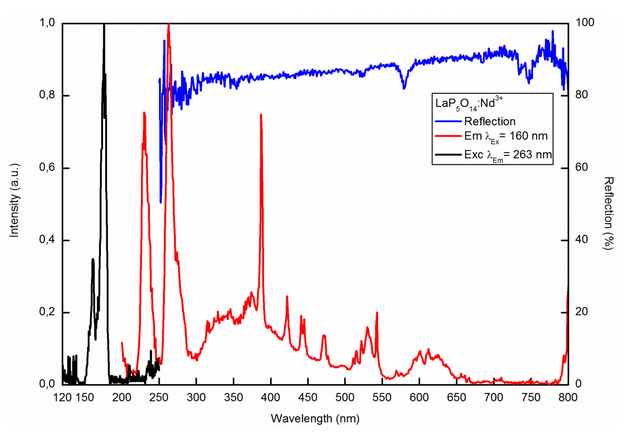
Reflection spectra of LaP_5O_{14}

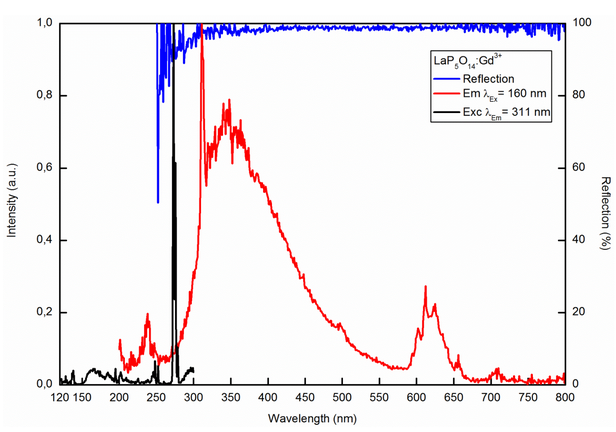


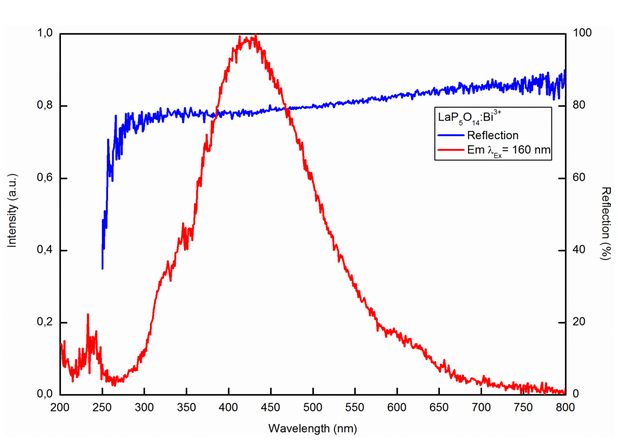
IR spectra of LaP_5O_{14}

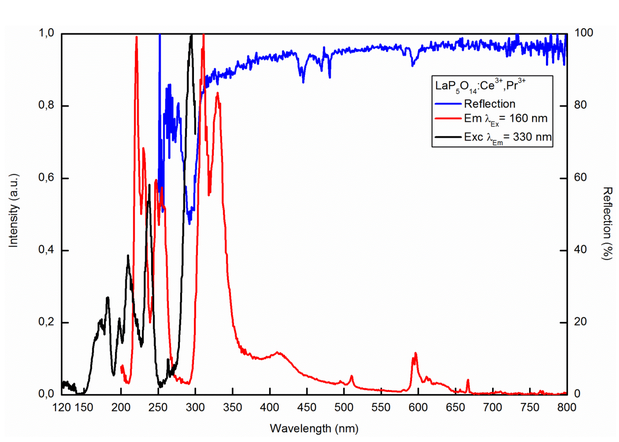


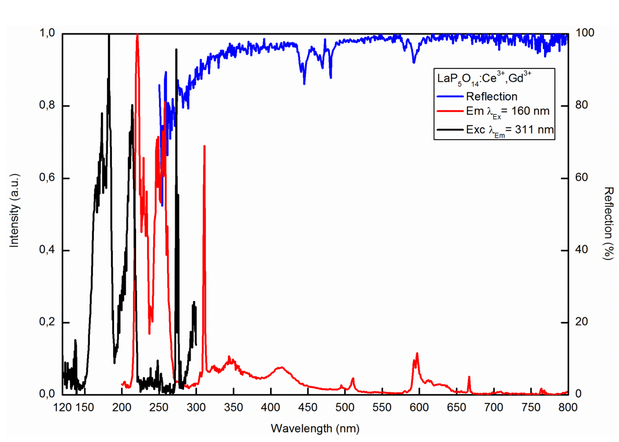












From Left to Right: Reflection, emission and excitation spectra of doped LaP_5O_{14}

Conclusions

In summary, the ultraphosphate LaP_5O_{14} was successfully prepared via a high temperature solid state reaction and doped with Rare Earth ions (Ce^{3+}, Pr^{3+}, Nd^{3+}, Gd^{3+}) or Bi^{3+}. Diffraction patterns of all samples show the presence of monoclinic LaP_5O_{14}. Traces of an undefined impurity phase can also be discerned. Reflection spectra indicate the highest crystallinity for calcination temperature of 900 °C. Phonon frequency was detected at 1355 cm^{-1} wavenumbers. Emission spectra of doped LaP_5O_{14} show characteristic activator emission. In some cases overlapped by defect emission. Ce^{3+}/Pr^{3+} and Ce^{3+}/Gd^{3+} codoped samples show energy transfer from Ce^{3+} to Pr^{3+} and Gd^{3+}, respectively.

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