On the Host Lattice KY$_3$F$_{10}$ Doped by Trivalent Praseodymium as a Transparent Ceramic Laser Material

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Background
Laser projection is regarded as the future technology for digital projection. To realise a full colour laser TV set according to the RGB concept an array of three laser types is thus required. For red and blue efficient laser diodes are already available. Since there are no efficient green emitting laser diodes commercially available yet, the conversion of the blue laser by a luminescent screen is still of interest.

Fig. 1 Principle of light conversion

Synthesis
Powder preparation was performed by conventional solid state chemistry methods. As starting materials high purity KF, YF$_3$, and PrF$_3$ were used. Appropriate blends were sintered for 4 h at 650 °C in a Nitrogen stream to obtain single phase material. The fluorescence spectra show excitation lines in the blue spectral range and emission lines in the green and red spectral range due to the [Xe]4f 2 - [Xe] 4f2 transitions of trivalent Praseodymium. The mean particle size of the powder is 1 – 2 µm and forming agglomerates with a size of about 10 µm.

Fig. 2 Crystal structure of KY$_3$F$_{10}$

Conclusions
Upon pressing the obtained powders uniaxially and isostatically for one hour to achieve pellets with a high green body density. These green bodies were subsequently sintered for several hours at 800 °C in a Nitrogen stream. The resulting translucent ceramics were characterized by optical spectroscopy.

Fig. 6 Spectrometer set-up to record luminescence spectra in transmission mode

Fig. 7 Blue LED and resulting spectrum upon passing a KY$_3$F$_{10}$:Pr$^{3+}$ ceramic

Upon passing a KY$_3$F$_{10}$:Pr$^{3+}$ ceramic, a laser diode commercially available yet, the conversion of the blue laser by a luminescent screen is still of interest.

Fig. 8 Example of a typical translucent KY$_3$F$_{10}$:Pr$^{3+}$ ceramic

In this study, the host lattice KY$_3$F$_{10}$ was investigated. It exhibits a cubic crystal system (a = 11,543 Å), low phonon frequencies (approx. 420 cm$^{-1}$), and a wide band gap (10 eV), which are some of the most important requirements to a transparent laser material. The host lattice was doped by trivalent Praseodymium onto the Y$^{3+}$ position as the active medium.

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