$Ba_2LaF_7:RE^{3+}$ - Ceramic as Potential Laser Material

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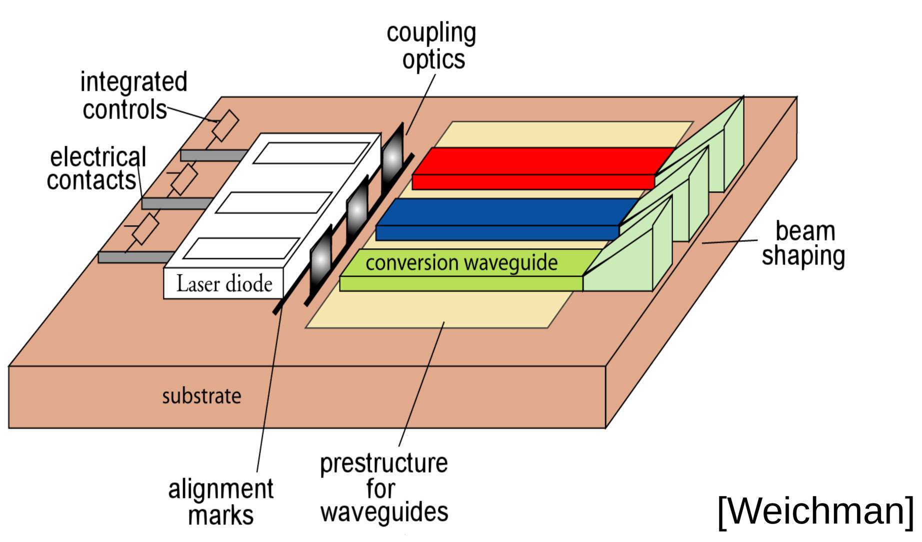
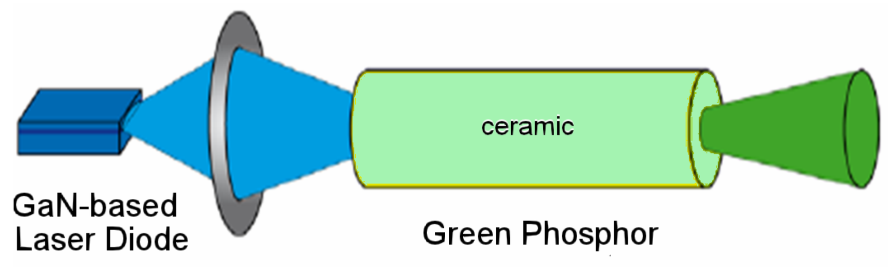
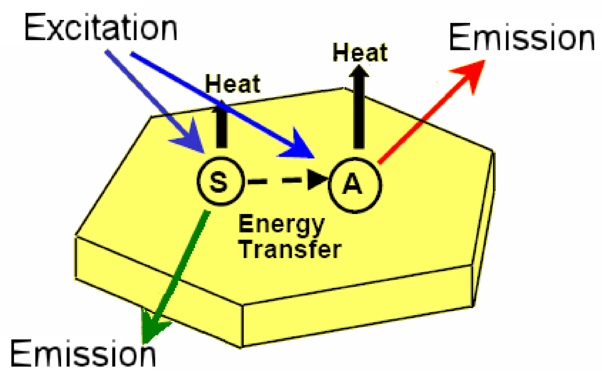
Solid state LASERs mostly rely on single crystalline transparent bodies as the active LASER medium, which is pumped by flash lamps. Recently, some LASER types take advantage of the application of ceramic discs or bodies, since transparent ceramics broaden the range of applicable material compositions.Solid state LASERs using (Al,In,Ga)N or (Al,In,Ga)P semiconductors as active media are well-established for the blue and red spectral range. Green emitting semiconductor LASERs with high power are not feasible yet. A potential way to achieve green emitting solid state LASERs is the application of blue LASER diodes, which pump a green emitting (520 - 540 nm) LASER crystal or ceramic.



Integrated RGB Laser source



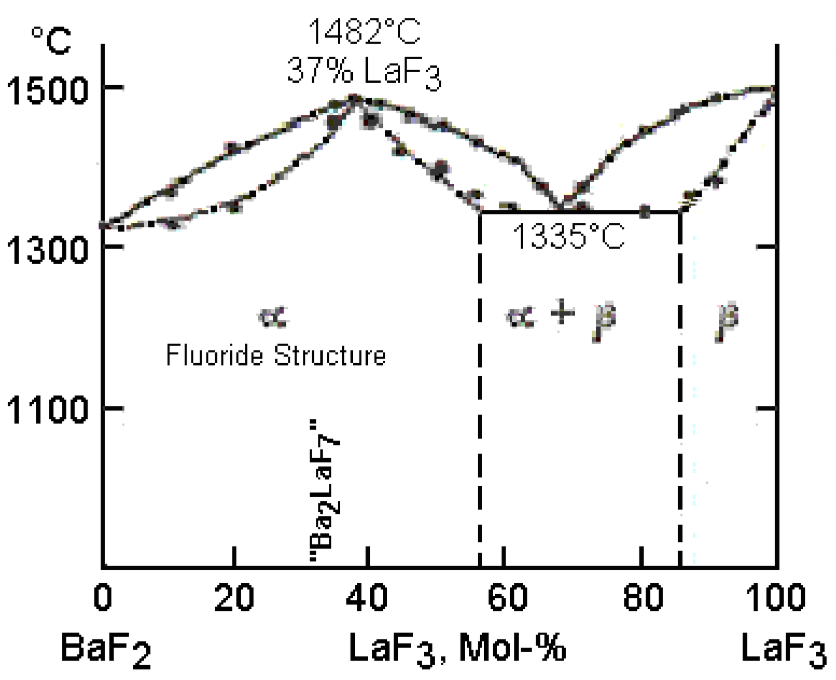
Green phosphor for the conversion of blue light



Phosphor = crystalline host lattice doped by an activator

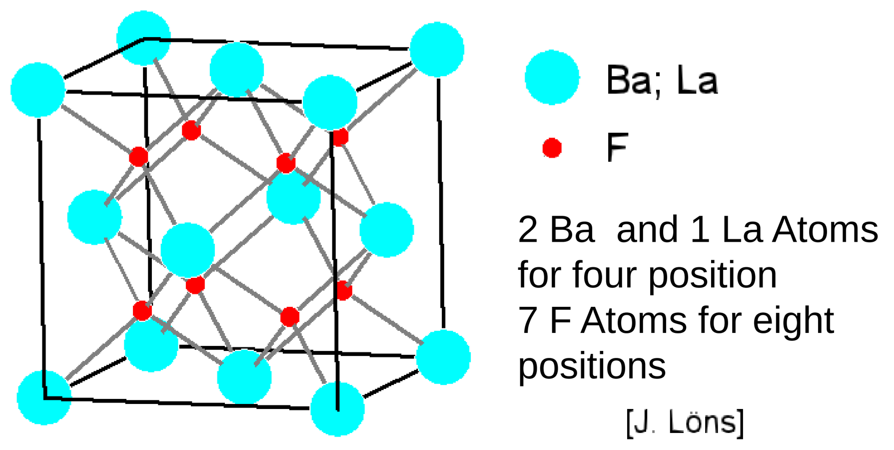
By the realisation of a green emitting solid state LASER, an RGB projector using an RGB LASER set will become feasible. This requires green emitting luminescent materials, which can be pumped by blue radiation and which are not suspected to show excited state absorption. Ba_2LaF_7 (BLF) crystallising in the cubic crystal system is of high interest for the production of transparent ceramics due to its isotropic refractive index.

Solid solution of $Ba_{1-x}La_xF_{2+x}$ for x = 1/3 or compound Ba_2LaF_7



Phase diagram of BaF_2-LaF_3

B.M. Zhigarnovskii, E.G. Ippolitov, Neorg. Mater., 5 (1969) 1806

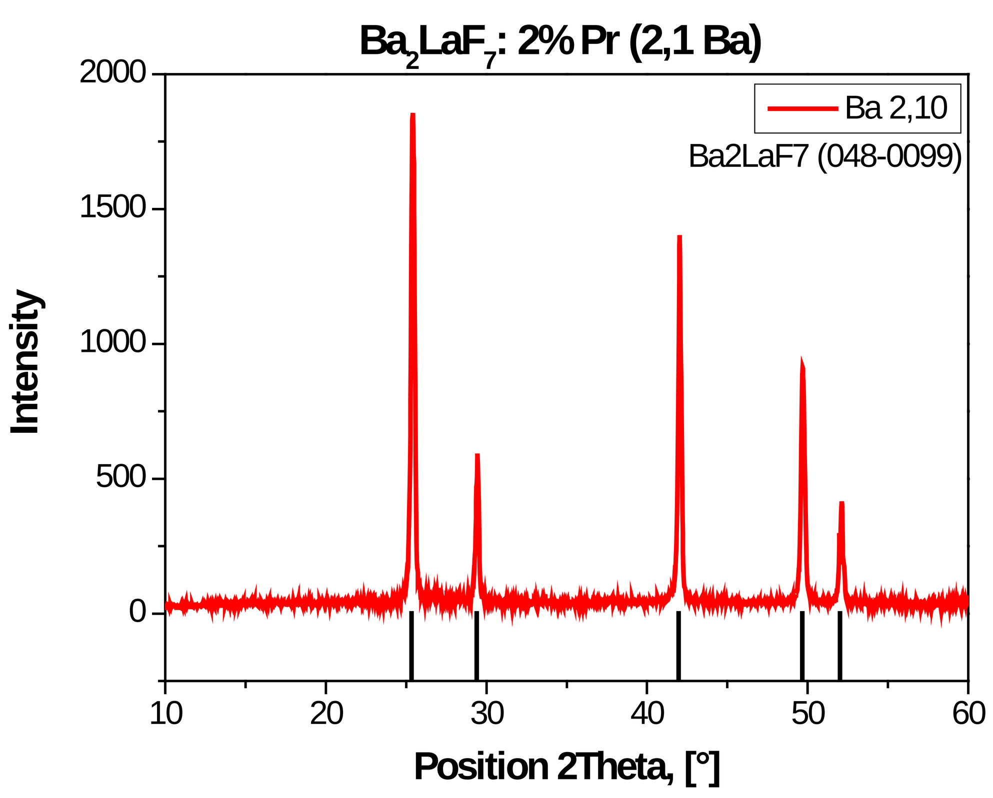


Defect structure of Ba_2LaF_7; cubic, a = 0.6088 nm (proposal)

RE-Ion	Electron configuration	Ground state	Ion radius (CN = 8)
Pr^{3+}	$4f^2\,5s^2\,5p^6$	$^3H_4$	126,6 pm
Er^{3+}	$4f^{11}\,5s^2\,5p^6$	$^4I_{5/2}$	114,5 pm
Ho^{3+}	$4f^{10}\,5s^2\,5p^6$	$^5I_3$	115,5 pm
La^{3+}	[Xe]	$^1S_0$	117,2 pm

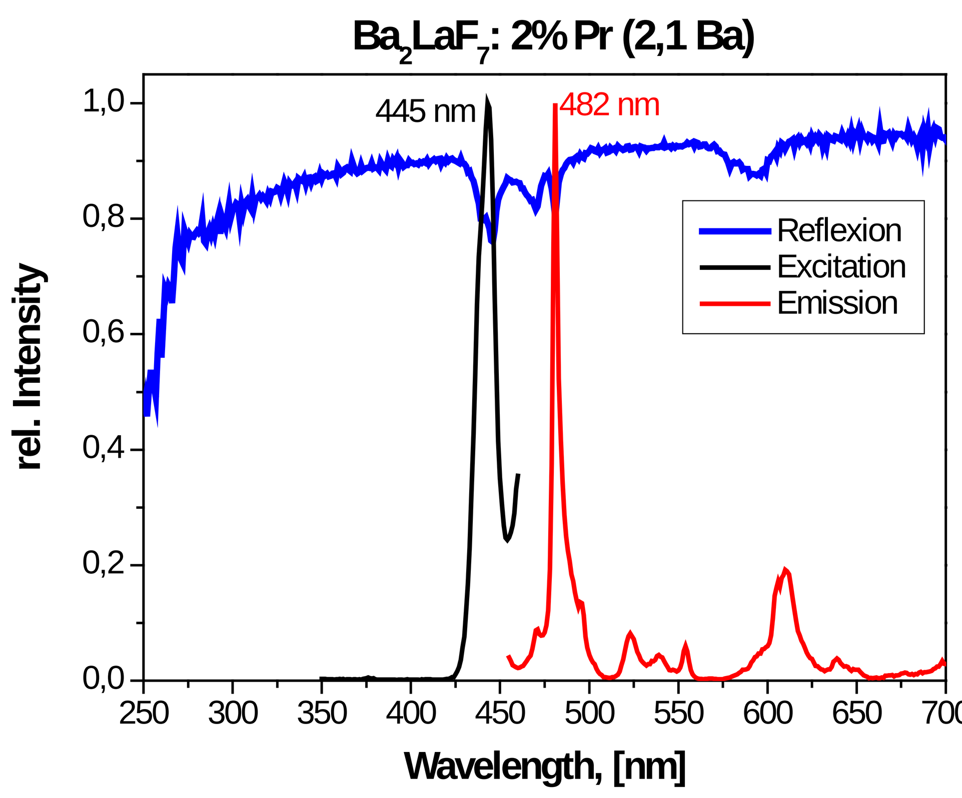
Activator ions

Samples as prepared in this work were made by the ceramic method in a reducing atmosphere, i.e. under CO, at about 1350 °C. To explore the luminescence spectra, BLF were doped by 0,5 to 1,0% of Pr^{3+}, Ho^{3+}, or Er^{3+}. Emission spectra reveal that all samples show efficient luminescence in the green spectral range due to 4f-4f transitions of the respective trivalent rare earth ion.

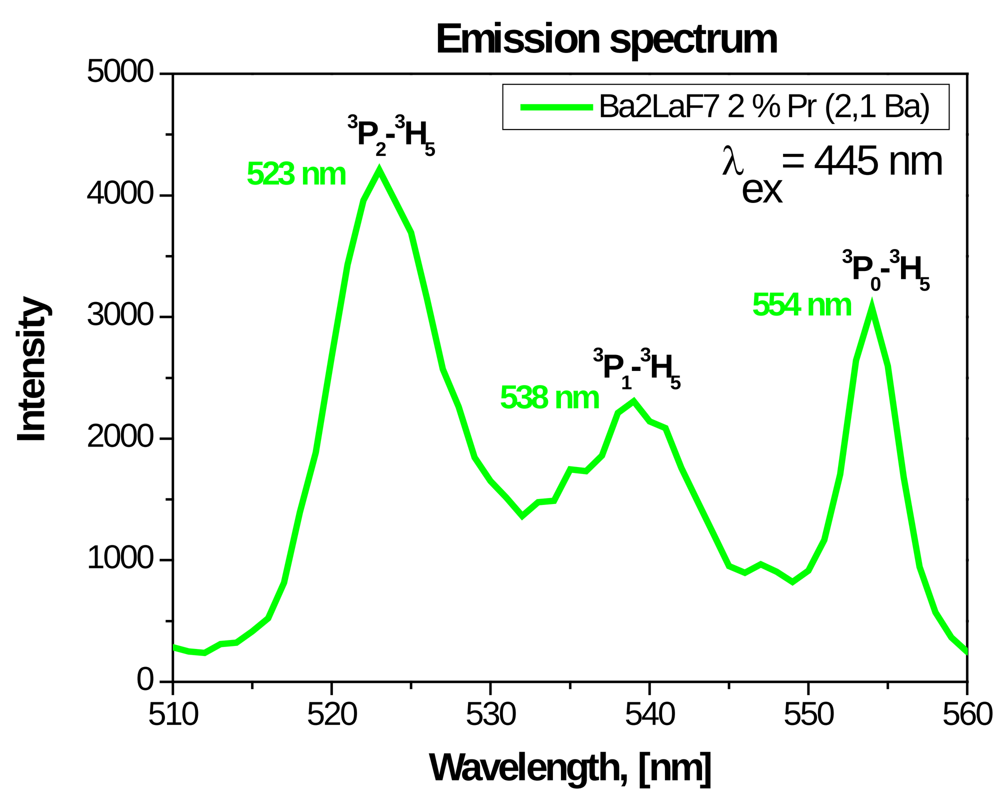


XRD Analysis

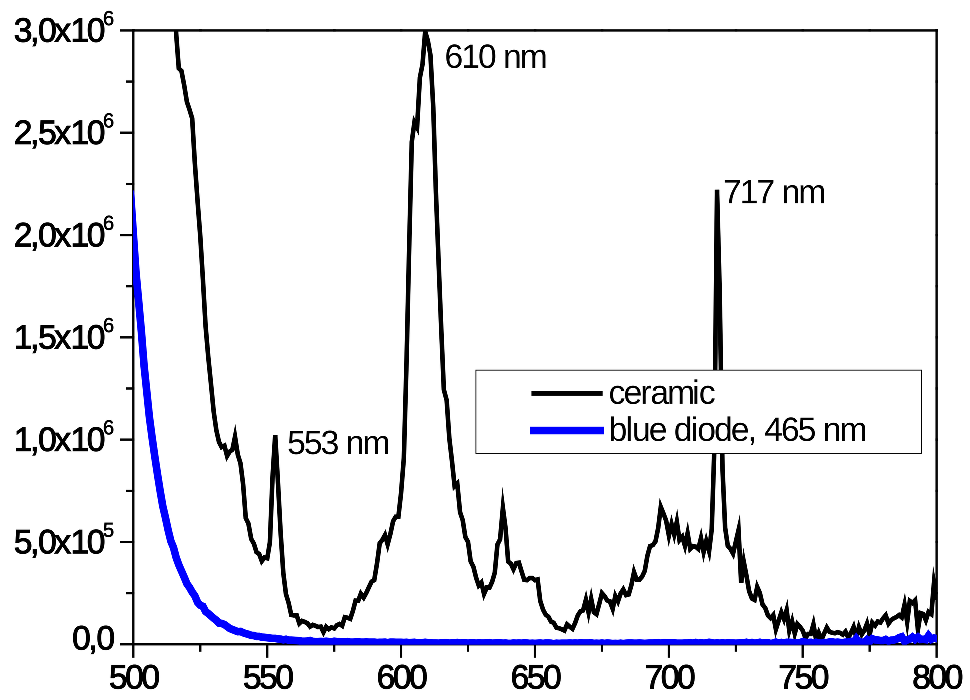
Ceramic Body



Optical spectra

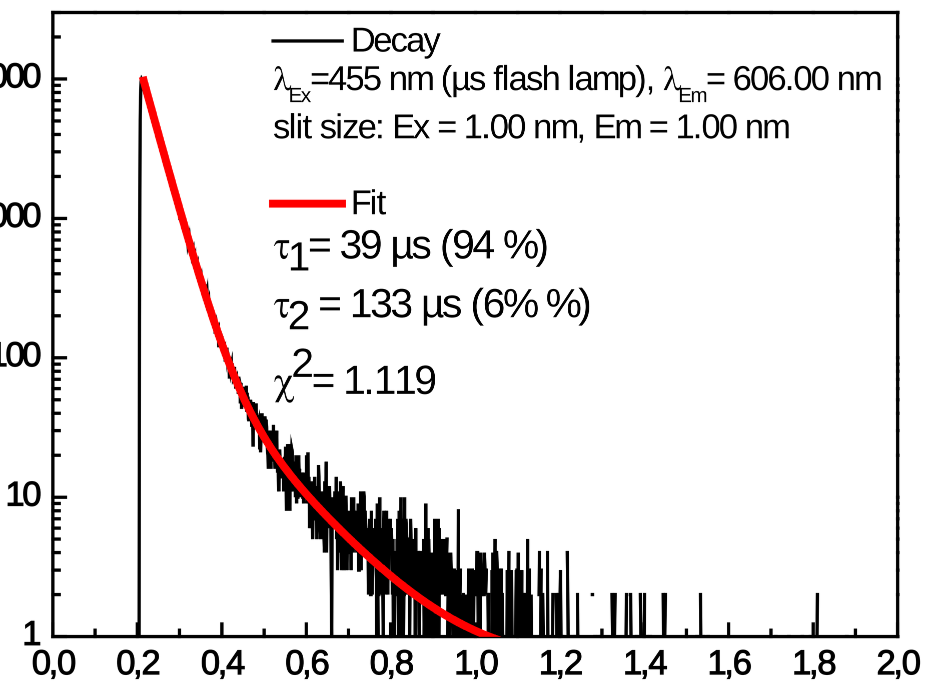


Green emission range

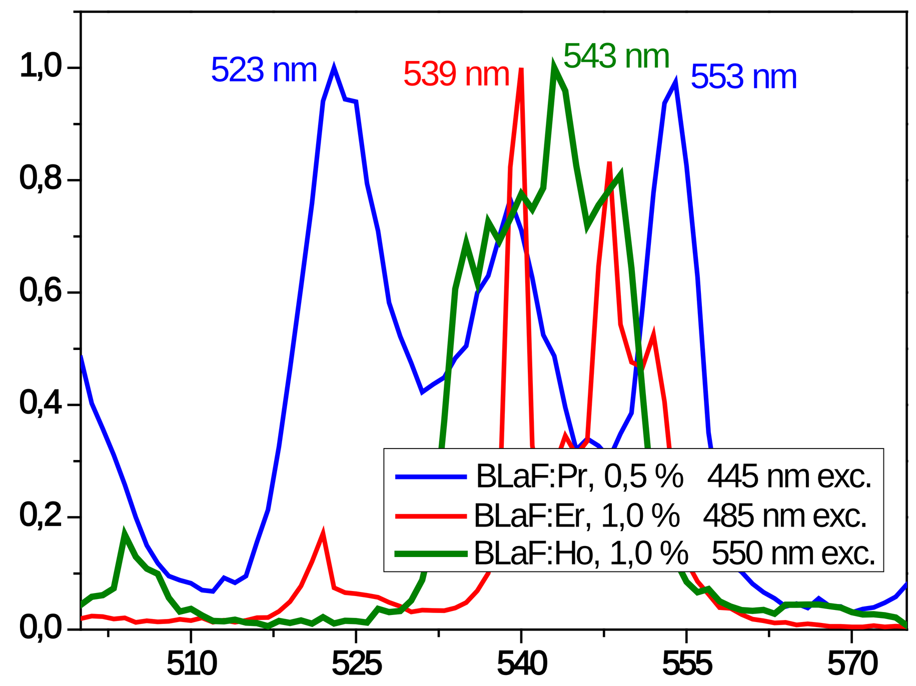


Ceramic sample under blue diode

Ceramic body excited by a blue diode



Decay time spectrum excited with λ_{ex} = 455 nm



Emission spectra of $Ba_2LaF_7:RE^{3+}$

Conclusion: BLF was doped by 0,5 to 1,0% of Pr^{3+}, Ho^{3+}, or Er^{3+} and shows for each ion emission in the green spectral range. The most intense emission peak for $Ba_2LaF_7:Pr^{3+}$ appears at 481 nm, for $Ba_2LaF_7:Er^{3+}$ at 538 nm and for $Ba_2LaF_7:Ho^{3+}$ at 544 nm. However, solely $Ba_2LaF_7:Pr^{3+}$ can be excited at 440 nm, which is the required wavelength as given by the diode LASER.