Valence regulation of cerium ions in borosilicate (borogermanate) glass scintillator synthesized in air atmosphere

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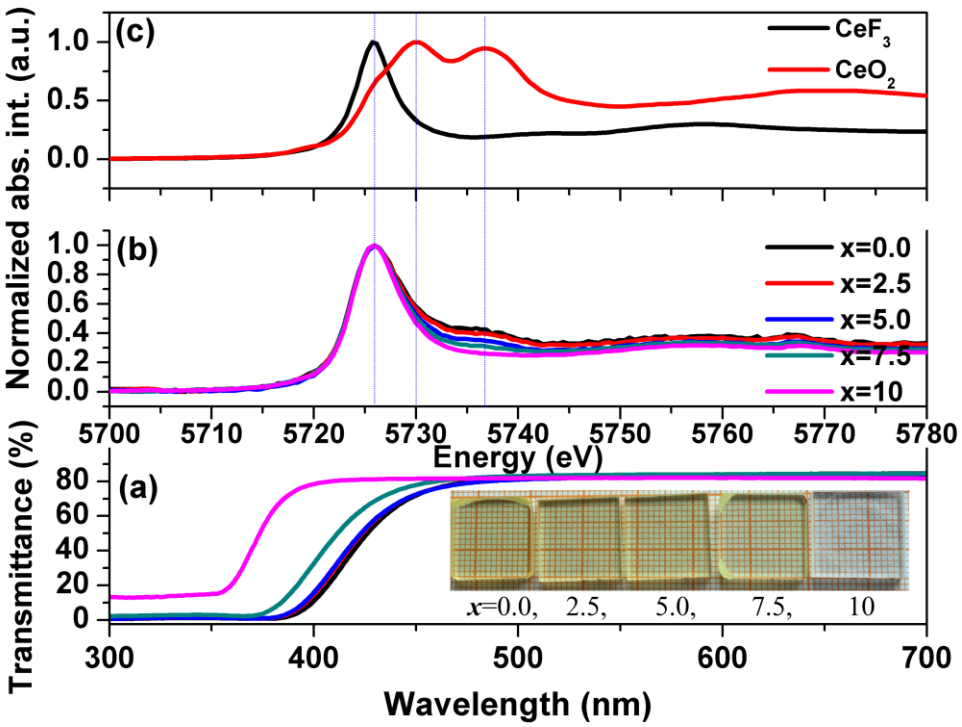
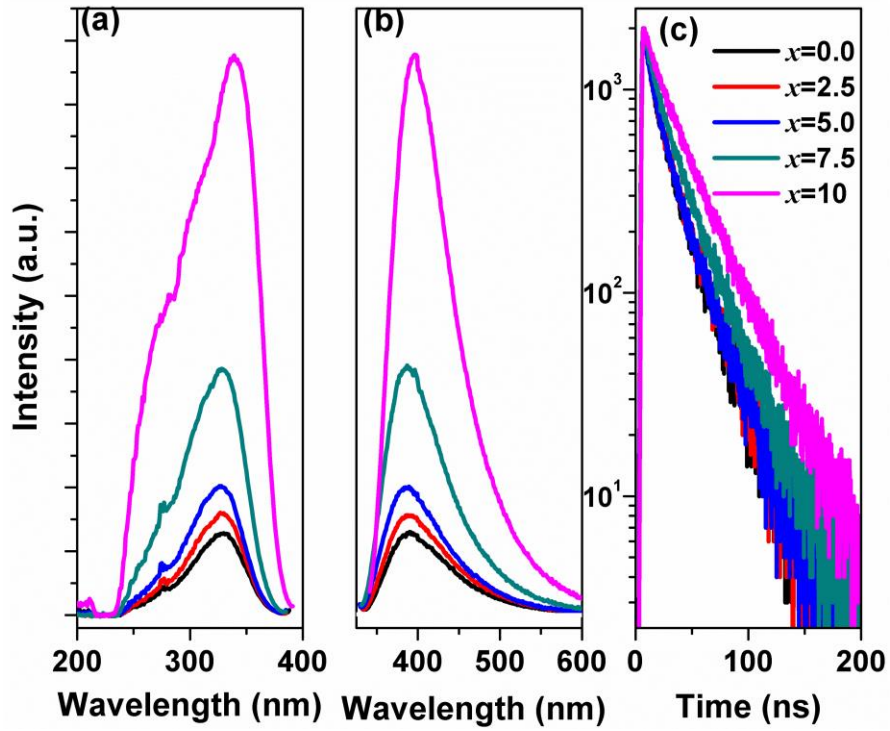
1. Optical and photoluminescence—Al

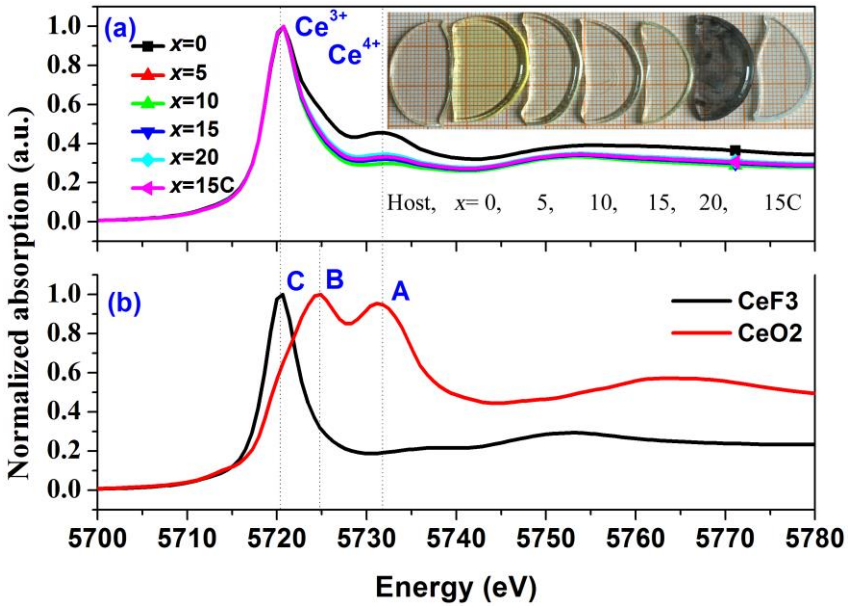




- The optical transmittance of all borosilicate glasses is higher than 80% in the 470-700 nm wavelength regions, and the UV cut-off edge decreases monotonously from 387 to 347 nm with an increasing substitution of BaO by Al_2O_3.
- With comparison to the x=0 glass, the integral emission intensity of the x=10 glass is enhanced by about 6.7 times, which is mainly resulted from the increasing concentration of Ce^{3+} ions tuned by the full replacement of BaO by Al_2O_3.

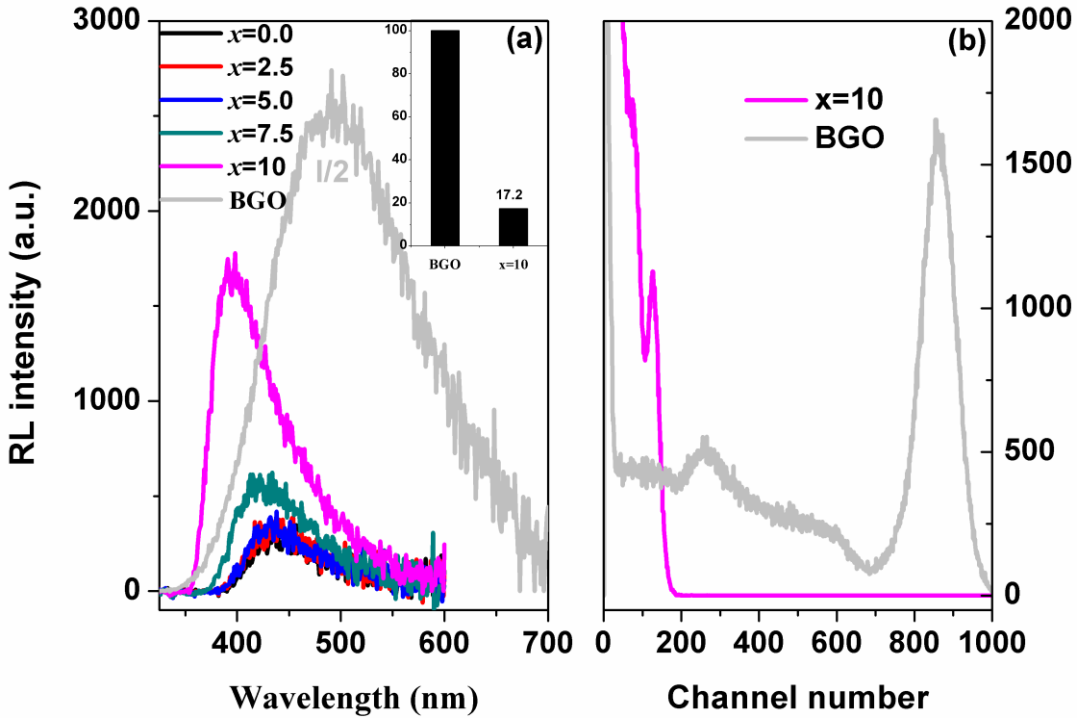
2. Optical properties—Si

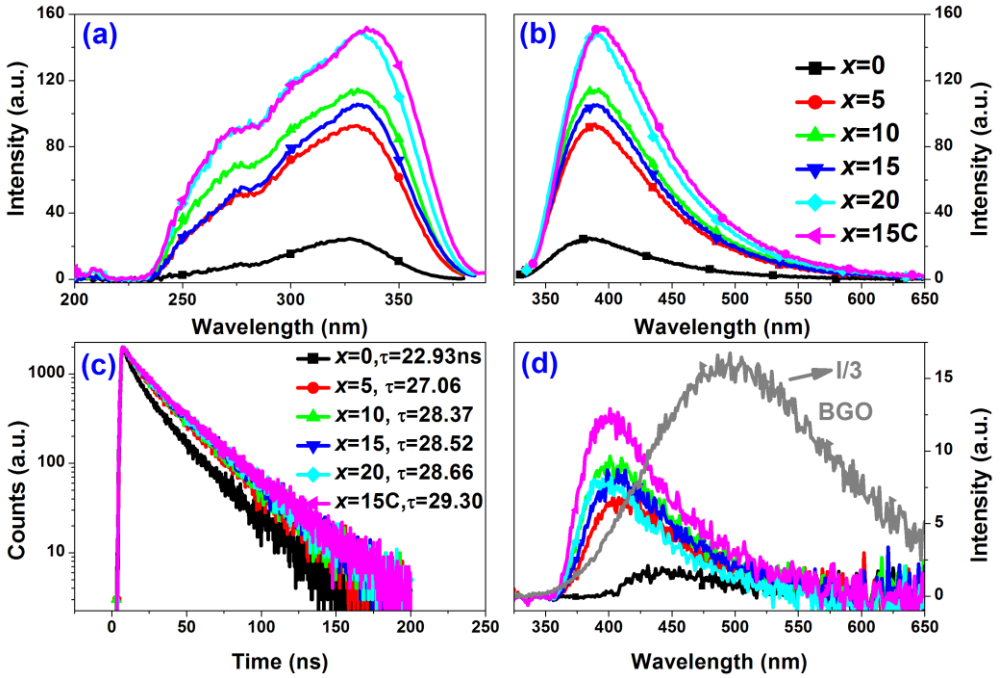
No.	B_2O_3	SiO_2	SiC	Al_2O_3	Gd_2O_3	CeF_3	Density (g/cm^3)	Lifetime (ns)	Ex/Em (nm)	Δλ (nm)
Host	30	25	0	10	35	0	4.878	-	-	-
x=0	30	25	0	10	34	1	4.858	22.93	326/386	60
x=5	30	20	5	10	34	1	4.926	27.06	329/387	56
x=10	30	15	10	10	34	1	4.882	28.37	331/388	57
x=15	30	10	15	10	34	1	4.880	28.52	331/390	59
x=20	30	5	20	10	34	1	4.969	28.66	332/391	59
x=15C	30	10	15	10	34	1	4.940	29.30	335/394	59



- The XANES spectra of glass scintillators show the characteristic features of both Ce^{3+} and Ce^{4+} ions. The x=0 glass one prepared without any SiC or C incorporation exhibits much higher Ce^{4+} concentration compared to the other samples.
- The attractive reducing effect of the proper quantities of SiC is able to be illustrated by the colour of borosilicate glasses glass scintillators due to the absorption edge differences in visible light. The colour of borosilicate glass scintillator changes from heavy yellow, light yellow, even to nearly completely colourless.

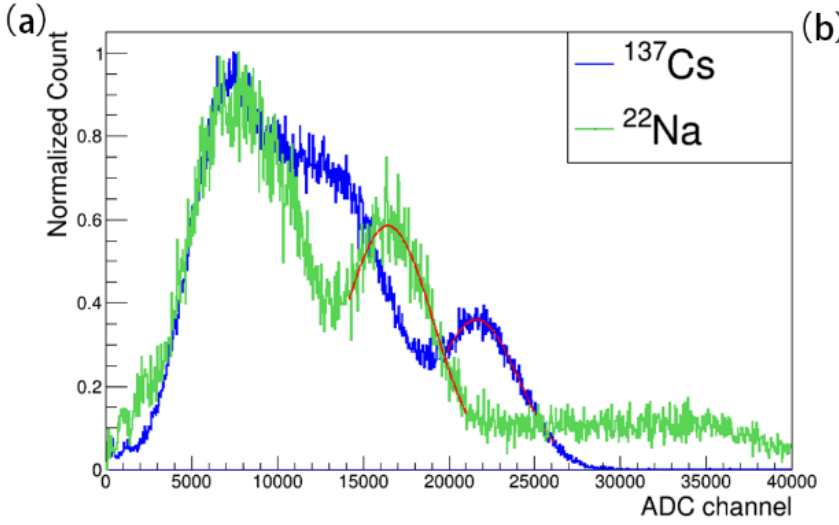
3. PL and XEL

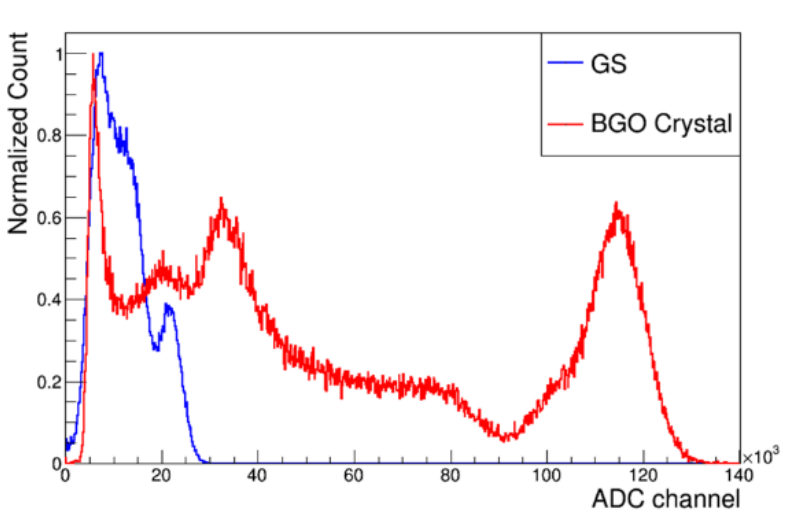


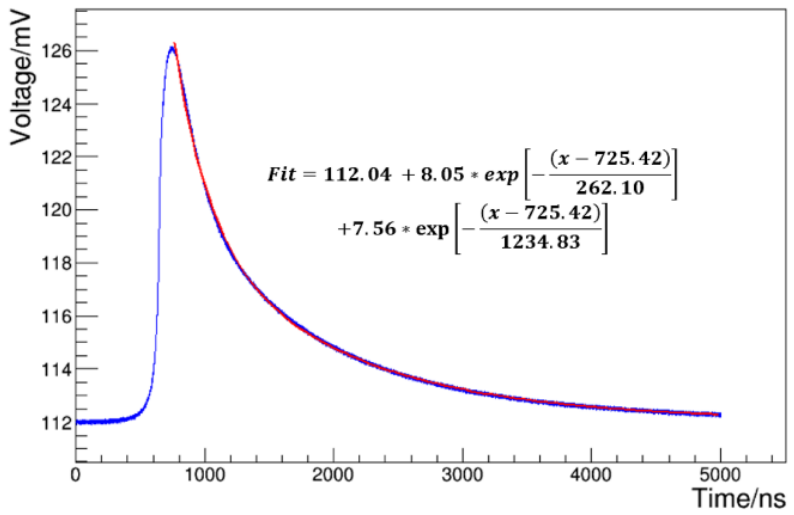


- Al source—In XEL, integral emission intensity of the glass (Al) is about that of 17.2% BGO crystal. Under ^{137}Cs Gamma source, the light yield of the glass is about 14.7% of that of the BGO crystal.
- Si source—The maximum XEL intensity is still also the x=15C glass scintillator, whose integral emission intensity is about that of 14% BGO, and it is being higher than that of the x=0 glass scintillator by a factor of 7.7.

3. Scintillation







- Through calculation, the LY of the glass is about 802 ph/MeV. The measured energy resolution ($\Delta E/E$) of glass scintillator is obtained by fitting the full-energy peak. The measured energy resolution of the glass is 26.77% @662 keV.
- The scintillation decay time of the fast and slow components is 262.10 ns (18%) and 1234.83 ns (82%), respectively. The fast component is attributed to the 5d-4f transitions of Ce^{3+} in host glass and the energy transport to Ce^{3+} center results in the slow component. Due to the re-trapping processes during the transport stage, the scintillating decay times of the glass are often show the slower components.

Thank you!