Lithium silicate crystals for neutron scintillators

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Neutrons have recently become essential probes in material research on both macroscopic and microscopic scale. They can be applied in various imaging techniques or scattering techniques to investigate material or molecular structure and so on. We can also mention possible applications in security systems or oil well logging. Due to the gradually decreasing abundance of the ^{3}He gas, the alternative detection techniques should be searched for to replace the ^{3}He-based detectors. Li-containing inorganic scintillation crystals have been investigated for such a purpose. Recently we have shown that 0.1% Ti-doped $LiAlO_2$ crystal can be a good candidate for novel neutron scintillation material due to Li-content, low density of about 2.75 g/cm^3 (and resulting low gamma-ray sensitivity) and a relatively high neutron light yield of 6000 photons/neutron, which is comparable to commercially available Ce-doped Li-glass.

Another possible candidate can be the Ti-doped Li_4SiO_4 crystal with even lower density (2.35 g/cm^3) and twice as high Li content. We have optimized the micro-pulling-down method for crystal growth of Li_4SiO_4 taking into account the Li evaporation. The picture of the the Ti 0.2mol% -doped Li_4SiO_4 single crystal is shown in the inset of the figure 1. The figure shows also the comparison of the X-ray-excited radioluminescence spectra of the Ti 0.2mol% -doped Li_4SiO_4 crystal with $Bi_4Ge_3O_{12}$ (BGO) standard scintillator. We can see that the overall scintillation efficiency reaches as high as 250% of that of BGO. The high overall scintillation efficiency under X-ray would make this material promising also for the neutron detection. Even though the Ti was introduced as trivalent using the Ti_2O_3 starting material, it seems that the Ti^{3+} was oxidized to Ti^{4+}, as the spectrum is greatly similar to that of the previously studied sample where Ti^{4+} dopant was introduced intentionally. Crystal growth and basic luminescence and scintillation study of this material system will be presented and discussed.

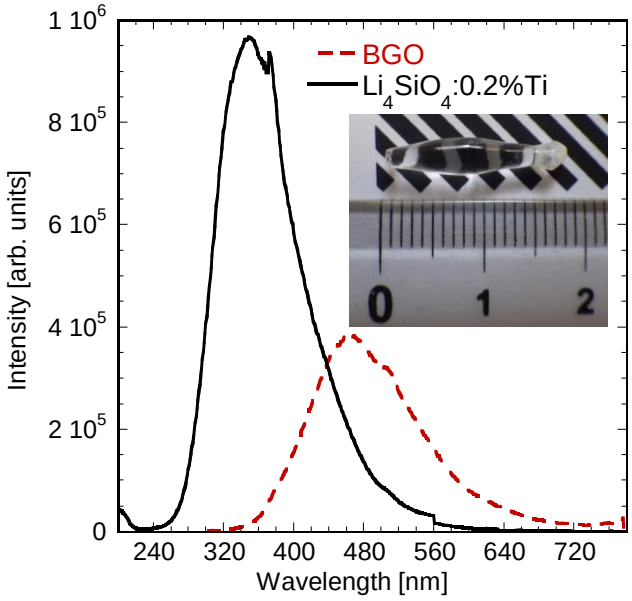

Figure 1. Comparison of the X-ray-excited radioluminescence spectra of Li_4SiO_4:Ti 0.2% with BGO standard scintillator.