Red-emitting Li_2MnCl_4 for neutron detection: crystal growth and new doping strategies

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Scintillators are energy converters of ionizing radiation into photons in the visible, UV, and even IR regions. These emitted photons are detected by photodetectors (e.g., photomultiplier tube (PMT) or silicon-based photodetectors) and transformed into photoelectrons by multiplying the initial weak signal, which can be recorded with software [1,2]. The scintillator together with the photodetector form the scintillation detector.

Nowadays, neutron scintillators have their emission spectrum usually optimized for PMTs, for whose optimum wavelength in near UV-blue spectral region is demanded. However, in the field of neutronography, silicon-based photodetectors are desirable. Silicon-based photodetectors (charge-coupled device (CCD), thin-film transistor (TFT), avalanche photodiode (APD)) are generally less bulky, lighter, and cheaper than PMTs, they operate at lower voltages, and their maximum quantum efficiency is highest in the range of wavelengths above 500 nm. Therefore, a scintillator for thermal neutron detection based on reaction $^6Li(n, \alpha)^3H$ with emission in longer wavelengths would be optimal for silicon-based photodetector. Such a scintillator has not been under intensive development so far.

In our previous work, we introduced a novel red-emitting scintillator Li_2MnCl_4, with high lithium content (28.5 at%), low density (ϱ = 2.4 g/cm^3), low effective atomic number (Z_{eff} = 17.1) and emission in the red-NIR region [3]. These characteristics make Li_2MnCl_4 a promising candidate for measurements in high-flux mixed neutron-gamma fields. Moreover, the red-NIR emission is favorable for modern semiconductor photodetectors. The luminescence properties of Li_2MnCl_4 influenced by concentration quenching in the Mn^{2+} sublattice and further shaped by doping with Eu^{2+} and Ce^{3+} were also described.

In this work, we would like to follow up on the previous research by studying dopants with emission in longer wavelengths, such as Sm^{2+}, Ti^{3+} or In^{+}.

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