Investigation of the phase diagram of the CsI-LiBr system and fabrication of the eutectic scintillator for thermal neutron detection

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[Introduction] Thermal neutron detectors are widely used in numerous fields. Recently, they have been also attracted attention in the field of lithium-ion battery internal structure observation, further increasing demand. Until now, ^{3}He gas detectors have been widely used for thermal neutron detection, but the supply of ^{3}He gas has been decreasing due to restrictions placed on its export by major ^{3}He gas producing countries. To fill this growing gap between supply and demand, solid scintillators for thermal neutron detection based on the ^{6}Li(n,α) reaction have been developed, which have a large neutron capture cross section. Recently, ^{6}Li-containing eutectic scintillators such as LiF/$LiGdF_4$ and $LaBr_3$/LiBr [1,2] have been reported. These eutectic crystals consist of a ^{6}Li-based neutron capture phase and a scintillator phase that emits light due to α-rays. In this study, a Tl doped ^{6}LiBr/CsI optically transparent eutectic was proposed as a novel thermal neutron scintillator due to promising properties of Tl:CsI scintillator phase such a high light yield (56,000 photons/MeV), high α/β (0.66), and refractive index close to that of ^{6}LiBr neutron capture phase (CsI:1.787@540nm, LiBr:1.785@540 nm) [3]. However, Neither the phase diagram nor the eutectic point is reported.

[Experimental method] First, the LiBr-CsI phase state diagram was investigated. At the corresponding mixing ratios, each raw material (4N purity) was weighed, fed into sample cells in a glovebox under Ar atmosphere, and vacuum sealed. Differential scanning calorimetry (DSC) was then performed. Next, a ^{6}LiBr/Tl:CsI eutectic was fabricated at the eutectic point. The raw materials were weighted in a glovebox using a quartz ampoule with an inner diameter of 6 mm and baked at 300 ℃ under vacuum (~10^{-5} Pa) for 3 hours before sealing. After that, crystals were grown using the Vertical Bridgman method at a pulling-down rate of 0.2 mm/min.

[Results] Obtained phase diagram from the DSC results was showed in Fig.1. From the phase diagram, the eutectic point was found to be 40 mol% CsI-LiBr. Fig.2 shows a photograph of 1 mm thick the polished eutectic wafer and BEI. The grown eutectic was found to be optically transparent. Combined with the powder XRD results, the expected CsI and LiBr phases were confirmed. Detailed experimental methods and scintillator properties will be reported on the day of the conference.

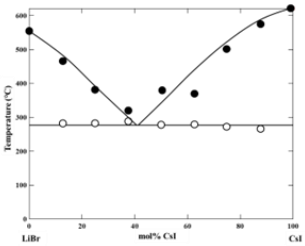

Fig.1 The LiBr-CsI phase state diagram

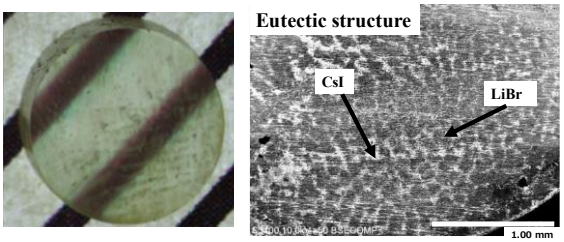

Fig.2 A photograph of 1 mm thick polished eutectic wafers (left) and (right) BEI of the wafer

References

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