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Scintillation Properties of (Zn, Mg) WO4 for Dark Matter Search

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Dark Matter is one of the biggest issue in modern physics, and ones of the candidates for the Dark Matters are weakly interacting massive particles (WIMPs) which are expected to form a halo around our Galaxy. Our Solar System is rotating around the center of the Galaxy, and we expect that the Earth should experience a "wind"(named 'WIMP wind') against the direction of the rotation, where is direction to Cygnus. Thus, it is expected to be one of the evidence of Dark Mater to detect the WIMPs wind from Cygnus, and a direction sensitive detector is required.
Up to now, several groups have developed such detectors using gaseous detectors, while gaseous ones have low detection efficiency. In this study, we propose a new type Dark matter detector with single crystals with which is expected to have higher detection efficiency than gaseous ones; $ZnWO_4$ and/or similar group can detect the direction of incident particles due to anisotropic [1]. However, the mechanism was not revealed.
We grew $ZnWO_4$ and (Zn, Mg)WO_4 single crystals with diameters of ˜0.5 inch grown by the Czochralski process to reveal the mechanism. The bulk crystals were cut to cubic shape samples with a size of 10 mm x 10 mm x 10mm, and each sample had the surfaces with c-axis orientation. Moreover, we check the crystal structure using the powder X-ray diffraction. Even these samples had good uniformities of material composition and transmittance, anisotropic scintillation properties were observed.
Light outputs of the crystal irradiated with 5.5 MeV alpha rays and 59.5 keV X-rays were estimated for each direction (orientation) for $ZnWO_4$ using a photo multiplier and an ^{241}Am source. Here, we evaluated the light output ratio: Alpha-ray to X-ray. As a results, b-axis orientation had different ratio from other surface, and we confirmed the anisotropic for $ZnWO_4$.
On the other hand, we found (Zn, Mg)WO_4 had smaller anisotropic effect than $ZnWO_4$. Moreover, the light output was smaller than $ZnWO_4$ by ˜25%. Here, lattice constant of b for (Zn, Mg)WO_4 was smaller than that for $ZnWO_4$ from X-ray diffraction pattern.
We discuss the mechanism of this anisotropic effect using also crystal structure data and other information in this presentation.

[1] F.A. Danevich et al., Nucl. Instrm. Meth. A544 552 (2005).

Has accepted

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