

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; ZnWO₄ and/or similar group can detect the direction of incident particles due to anisotropic [1]. However, the mechanism was not revealed.

We grew ZnWO₄ and (Zn, Mg)WO₄ 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 ZnWO₄ using a photo multiplier and an ²⁴¹Am 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 ZnWO₄.

On the other hand, we found (Zn, Mg)WO₄ had smaller anisotropic effect than ZnWO₄. Moreover, the light output was smaller than ZnWO₄ by ~25%. Here, lattice constant of b for (Zn, Mg)WO₄ was smaller than that for ZnWO₄ 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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