

## Magnetic and Optical Properties of $\text{MnIn}_2\text{Se}_4$ single crystal

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### 1. Introduction

$\text{Mn-III}_2\text{-VI}_4$  semiconductors have been widely studied for various nonlinear optical applications. Generally,  $\text{Mn-III}_2\text{-VI}_4$  compounds were found to be the tetrahedral bonded crystal structure [1].  $\text{MnIn}_2\text{Se}_4$  has several different crystal structures, trigonal, spinel-type and orthorhombic structures. Here we present the crystal structure and magnetic and optical properties of  $\text{MnIn}_2\text{Se}_4$  compound semiconductor.

### 2. Experiments

$\text{MnIn}_2\text{Se}_4$  bulk single crystal was grown by the vertical gradient solidification method. We used high-purity (99.999 %) Mn, In, and Se powders as starting materials with a particle size of <200 mesh to maximize the surface area and thereby enhance the reaction kinetics. The powders were weighed and loaded into thick walled quartz ampoule. Then the ampoule was evacuated ( $<10^{-6}$  Torr) and sealed. After encapsulation, the sealed ampoule was mixed, loaded into a vertical furnace, and heated slowly to form single-phase  $\text{MnIn}_2\text{Se}_4$ . The heating cycle was 30 °C/h to 1130 °C, 10 days soak. For single crystal growth, the temperature was slowly cooled at 1 °C/h to 800 °C, and thereafter at 100 °C/h. The crystal structure and composition was investigated using X-ray powder diffraction and electron probe micro analyzer (EPMA), respectively.

### 3. Results and Discussion

Trigonally structured  $\text{MnIn}_2\text{Se}_4$  is an indirect bandgap semiconductor with  $E_g=1.41$  eV. [2,3]. For the orthorhombic  $\text{MnIn}_2\text{Se}_4$ , Neumann et. al. [3] found an indirect transition at 1.378 eV followed by a second one at 1.56 eV which is supposed to be direct. In order to confirm above results, we have investigated optical properties of  $\text{MnIn}_2\text{Se}_4$  single crystal as a function of temperature. As a random distribution of Mn

on the cation sites, trigonally structured  $\text{MnIn}_2\text{Se}_4$  has antiferromagnetic behavior. In this talk, we will discuss the magnetic properties of  $\text{MnIn}_2\text{Se}_4$  for another crystal structures.

#### 4. References

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