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## Growth of CuInSe2:Co single crystal thin film for solar cell development and its solar cell application

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The stoichiometric mixture of evaporating materials for the CuInSe2 single crystal thin film was prepared from horizontal furnace. Using extrapolation method of X-ray diffraction patterns for the polycrystal CuInSe2, it was found tetragonal structure whose lattice constant a0 and c0 were 5.783 Å and 11.621 Å, respectively. To obtain the CuInSe2 single crystal thin film , CuInSe2 mixed crystal was deposited on throughly etched GaAs(100) by the HWE(Hot Wall Epitaxy) system. The source and substrate temperature were 620 ℃ and 410 ℃ respectively. The crystalline structure of CuInSe2 single crystal thin film was investigated by the double crystal X-ray diffraction(DCXD). Hall effect on this sample was measured by the method of Van der Pauw and studied on carrier density and mobility depending on temperature. From Hall data, the mobility was likely to be decreased by impurity scattering in the temperature range 30 K to 100 K and by lattice scattering in the temperature range 100 K to 293 K. The temperature dependence of the energy band gap of the CuInSe2 obtained from the absorption spectra was well described by the Varshni's relation, $Eg(T) = 1.1851\ eV - (8.99 \times 10^{-4}\ eV/K)T^2/(T + 153\ K)$. The open-circuit voltage, short current density, fill factor ,and conversion efficiency of n-CdS/ p-CuGaSe2 heterojunction solar cells under 80 mW/cm2 illumination were found to be 0.33 V, 29.5 mA/cm2, 0.78 and 14.7 %, respectively

**Keywords:** CuInSe2 single crystal thin film(CuInSe2 단결정 박막), Hall effect(Hall 효과), energy band gap

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## Photocurrent properties for CdIn2Te4 single crystal grown by using Bridgman method

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The single crystals of p-CdIn2Te4 were grown by the Bridgman method without the seed crystal. From photocurrent measurements, it was found that three peaks, A, B, and C, correspond to the intrinsic transition from the valence band states of Γ7(A), Γ6(B), and Γ7(C) to the conduction band state of Γ6, respectively. The crystal field splitting and the spin orbit splitting were found to be 0.2360 and 0.1119 eV, respectively, from the photocurrent spectroscopy. The temperature dependence of the CdIn2Te4 band gap energy was given by the equation of $Eg(T) = Eg(0) \simeq (9.43 \times 10^{-3})T^2/(2676 + T)$. Eg(0) was estimated to be 1.4750, 1.7110, and 1.8229 eV at the valence band states of A, B, and C, respectively. The band gap energy of p-CdIn2Te4 at room temperature was determined to be 1.2023 eV.

**Keywords:** p-CdIn2Te4,photocurrent measurement,Bridgman method,crystal field splitting,spin orbit splitting