Cd solvent to used THM by group-V doped CdTe single crystals by Cd-solvent THM

Introduction

Cadmium telluride (CdTe) has been well demonstrated as one of the promising photovoltaic material for solar cells because of its near-optimum bandgap of 1.5 eV and its high absorption coefficient, and is the only II-VI group semiconductor that can be relatively easily doped both p and n type conductivity. Recently, power conversion efficiency >22% was reported for polycrystalline CdTe cells, but further improvements rely on increasing p-type doping while maintaining long minority carrier lifetime. CdTe solar cells using P-doped bulk crystals as the absorber layer and exhibiting open-circuit voltage (V_OC) >1 V has been reported. Combined experimental and theoretical studies indicate that Cd-rich conditions are needed to achieve long carrier lifetime (>10 ns by suppressing Te on Cd antisites), but typical bulk crystal growth is carried out either stoichiometrically or in Te solvent. For these reasons, it is important to fundamentally understand bulk group-V doping in CdTe under Cd-rich conditions.

Experimental procedure

Group-V doped CdTe single crystals were grown by traveling heater method (THM) using Cd solvent and dopants such as Cd₃As₂. The structural, compositional and electrical properties were determined by powder X-ray diffraction (XRD), Energy Dispersive X-ray spectroscopy (EDX), Hall effect and capacitance-voltage (CV) measurements.

Results and Discussion

One of our goals in THM growth of CdTe using Cd solvent is to obtain Cd-rich composition single crystal and decrease growth temperature. Because of the high Cd vapor pressure, the ampoule loaded CdTe feed polycrystalline and Cd solvent was kept at 650°C for 24 hours to be stable as (Liquid + CdTe) phase and prevent explosion before heating up to growth temperature. Cd-rich CdTe single crystals can be obtained at growth temperature of 950°C and a growth speed of 4-5 mm/day. Figure 1 shows a CdTe ingot which was stopped in the middle of growth and exhibits a well-defined Cd solvent zone.