Area 3: Ⅲ - Ⅴ Compound Semiconductor and Concentrator and Space PV Technologies.

FABRICATION OF INGAP SOLAR CELLS WITH HYDRIDE VAPOR PHASE EPITAXY

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The reduction of PV power generation cost is an important issue of global energy policy. According to "NEDO PV Challenges", the target of PV electricity at 2030 is module efficiency of 25% and module cost of 7 yen/kWh (0.1 $/kWh). Therefore, the development of new solar cells having high efficiency and low cost becomes the urgent strategy. Against this background, Ⅲ−Ⅴ multi-junction (MJ) solar cell is one of the possibility to achieve this target. The Ⅲ−Ⅴ MJ solar cell has enabled very high efficiency over 30%. However, the problem of this solar cell is high cost due to the epitaxial growth method. Our target is to develop cost-effective and high throughput growth techniques. Against this background, hydride vapor phase epitaxy (H-VPE)[1)], in contrast with metal-organic vapor phase epitaxy (MO-VPE), can attain significantly high growth rates (~100 μm/h), and enables very low costs without expensive metal organic materials. Recently, we successfully demonstrated highly efficient GaAs cells grown by H-VPE[2)]. This work focuses on the fabrication of an InGaP solar cell grown by H-VPE.

Figure 1shows a schematic diagram of the fabricated InGaP solar cell with H-VPE (AsH3, PH3, HCl, Ga, In). Our H-VPE equipment has two growth chambers to form abrupt hetero interface through mechanical transfer of the wafer between each chamber[2)]. The source and substrate region are independently heated at 850℃ and 678℃, respectively. Growth rate for the InGaP was ~15 μ m/h. The device consists of $In_{0.48}Ga_{0.52}P$ absorption layer, $In_{0.48}Ga_{0.52}P$ emitter layer and lattice mismatch window $In_{0.25}Ga_{0.75}P$ layer on p-type GaAs (001) substrate. The I-V characteristic of the InGaP solar cell under 1 sun (AM1.5G) is shown in Fig. 2. The efficiency (η) was 8.06% with open-circuit voltage (Voc), short-circuit current density (Jsc) and fill factor (FF) of 1.20V, 9.00mA/cm^2 and 0.75, respectively. The device performance is presently limited by relatively low Jsc. Optimizing device structures, the efficiency over 10% can be realized. The improvement for device performance is currently ongoing in our group. These obtain results shows the possibility of the InGaP solar cells with H-VPE.

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[1] J. Simon et al., IEEE J. Photovolt., 6, 191 (2016). [2] R. Oshima et al., 44th IEEE Photovoltaics Specialists Conference, 235 (2017).

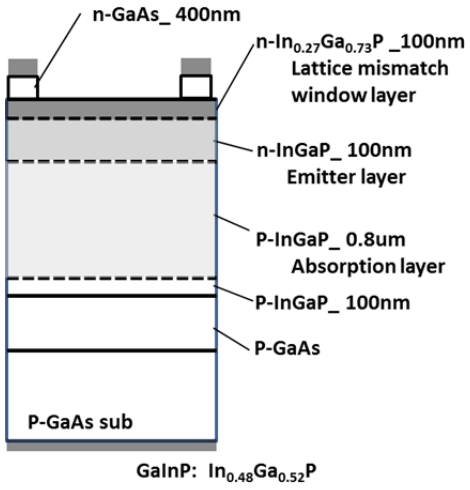

Figure 1: An InGaP solar cell with H-VPE.

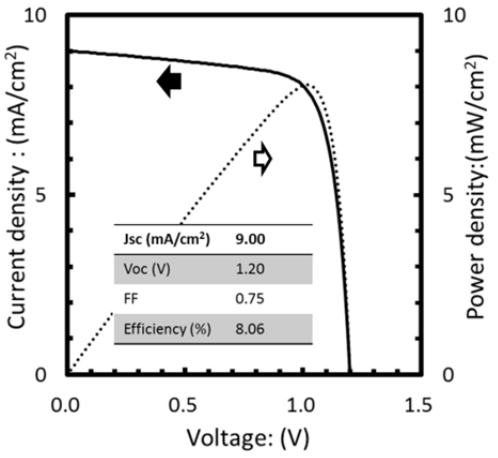

Figure 2: I-V characteristic of InGaP solar cell