Effect of Compressive Strain in Multiple Quantum Well Solar Cell

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InGaAs/GaAs compressive-strained (CS) and InGaAs/GaAsP strain-balanced (SB) multiple quantum well (MQW) solar cells were fabricated and characterized to investigate the effect of strain to the performance of MQW solar cells. By changing the barrier material from GaAsP to GaAs (Fig.1), the interfacial defects would decrease owing to smaller lattice mismatch between the well and the barrier materials, but the accumulation of strain in an entire MQW would increase. In this work, the samples of 5, 10 and 20-period of CS MQW, 10-period of SB MQW, nip and np GaAs reference cells were grown by metal-organic chemical vapor-phase deposition (MOCVD). For nip GaAs reference cell, the MQW layer was substituted by i-GaAs, and, for np GaAs reference cell, the i-GaAs top, MQW and i-GaAs bottom were substituted by p-GaAs base layer. Fig.2 shows the comparison of I-V characteristic and external quantum efficiency (EQE) between 10-period SB and CS MQW cells. The open-circuit voltage (V_{oc}) of SB MQW cell is 0.85 V, which is close to the V_{oc} of nip GaAs reference cell, whereas the V_{oc} of CS MQW cell was lower, 0.76 V. As shown in Fig. 3, the V_{oc} of CS MQW cell significantly decreases with increasing the number of MQW. This decrease of V_{oc} is attributed to the accumulated strain in the CS MQW structure.

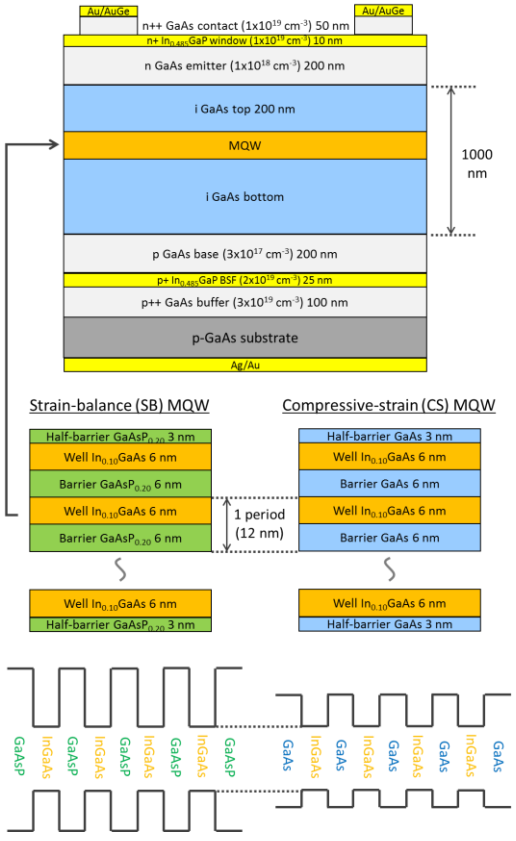

Fig.1 Sample structure of strain-balance (SB) and compressive-strain (CS) MQW solar cell

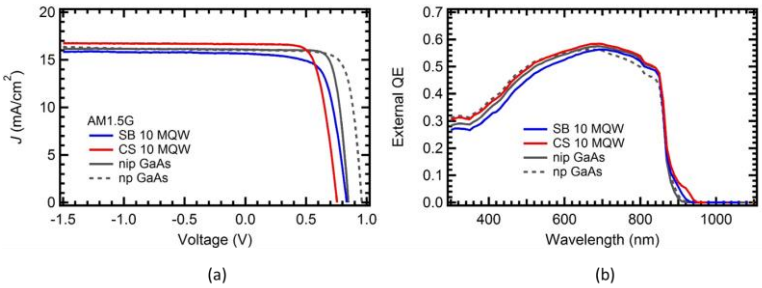

Fig.2 (a) I-V curves and (b) external quantum efficiency (EQE) of 10-period SB and CS MQW cells standardized with nip and np GaAs reference cells

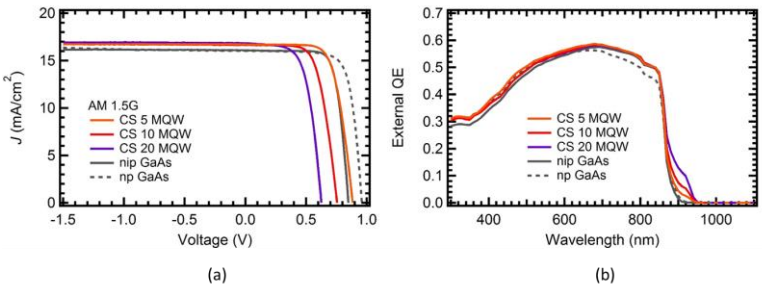

Fig.3 (a) I-V curves and (b) external quantum efficiency (EQE) of 5, 10 and 20-period CS MQW cells standardized with nip and np GaAs reference cells