Investigation of selective contacts for hot carrier solar cells

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Hot carrier solar cells are a concept of photovoltaic devices, which offer the opportunity to harvest more solar energy than the limit (33%) set by the Shockley-Queisser model. Unlike conventional photovoltaic devices, in hot carrier solar cells the excess kinetic energy is converted into useful electric power rather than being lost through thermalization mechanisms. To extract the carriers while they are still "hot", one needs to develop efficient energy selective contacts[1]. The presence of the hot carrier population in a p-i-n solar cell based on a single InGaAsP quantum well on InP substrate at room temperature has been demonstrated by means of complementary optical and electrical measurements[2], leading to working condition for this device above the limit for classical device operation. This result allows to design a new generation of devices for enhancing the hot carrier conversion contribution, provided that carrier extraction is improved.

In this work, we study InGaAs/AlInAs type II heterojunction as a selective contact. Two p-i-n solar cells have been grown by molecular beam epitaxy on InP substrate. The absorber layer is a 50nm-thick InGaAs absorber layer surrounded by an AlInAs barrier, all lattice-matched to InP. The first sample (Barrier) presents two symmetric 30 nm thick AlInAs barriers while the second sample has a 4nm InGaAs single quantum well (SQW) in the middle of the barrier (Fig 1). This SQW allows electron tunneling across the barrier to perform selective contact while the symmetric barrier sample acts as a semi-selective contact for electrons. I(V) characteristics under laser illumination with two different wavelengths show the effect of the selective contact compared to the barrier. For the 532 nm laser illumination, both samples present photocurrent while for the 1064 nm laser illumination, only the SQW sample allows carrier harvesting as shown on Fig. 2. A next step would be to adapt the confined level to hot carriers' energy.

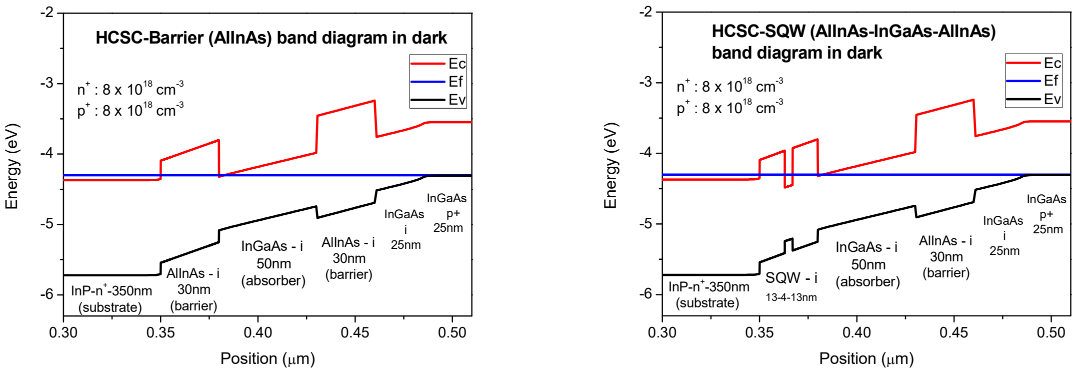

Fig. 1. Band diagram of HCSC barrier (left) and SQW (right) samples in dark

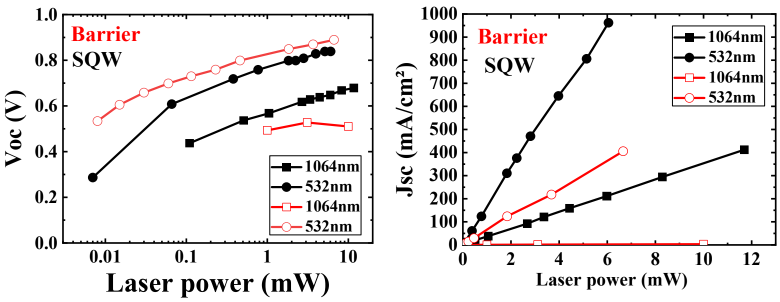

Fig. 2. V_{OC} (left) and J_{SC} (right) values as a function of laser power under different laser wavelengths for the Barrier sample (red) and for the SQW sample (black)

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