Design and elaboration of III-V heterostructures on InP substrates towards the development of HCSC with efficient semi-selective or selective contacts

F. Fan[1], S. Boyer-Richard[1], A. Beck[1], K. Tavernier[1], N. Bertru[1], N. Chevalier[1], J. Lapeyre[1], C. Cornet[1], A. Cattoni[2,3], J.-F. Guillemoles[3,4], L. Lombez[5], O. Durand[1].

[1] *Univ Rennes, INSA Rennes, CNRS, Institut FOTON - UMR 6082, F-35000 Rennes, France*

[2] *UMR 9001 CNRS, C2N, Site Marcoussis, Route Nozay, F-91460 Marcoussis, France*

[3] *IPVF, Institut Photovolta ïque d'Ile de France, 30 RD128 91120 Palaiseau, France*

[4] *CNRS, IPVF, 30 RD128 91120 Palaiseau, France*

[5] *Univ Toulouse, CNRS, INSA, UPS,LPCNO, 135 Av Rangueil, F-31077 Toulouse, France*

fei.fan@insa-rennes.fr

Hot carrier solar cells (HCSC) are one of the third generation photovoltaic devices, which offer the opportunity to harvest more solar energy than the limit (33%) set by the Shockley-Queisser model [1]. Unlike classical 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”, we need to develop efficient energy selective contacts. In this work, we investigate a set of HCSC with two different contacts (a semi-selective barrier and a selective single quantum well) to study the extraction of the hot carriers from the two contacts. The samples were made on InP (001) substrate, AlInAs barrier serves as the semi-selective contact and AlInAs-InGaAs-AlInAs single quantum well (SQW) serves as the selective contact.

This study is the first step towards the development of the HCSC. Firstly, we perform simulations for the two different selective contacts to obtain their band diagrams both under AM1.5G and in the dark. Secondly, we have grown the structures of real HCSC with a RIBER32 Gas Source MBE growth chamber, using Si for n-doping and Be for p-doping. In particular, the X-ray diffraction evidences the good lattice match of AlInAs barrier onto InP substrate. Thirdly, we have performed the technology steps to fabricate the HCSC devices. We present our work in the whole picture of design and elaboration of HCSC.

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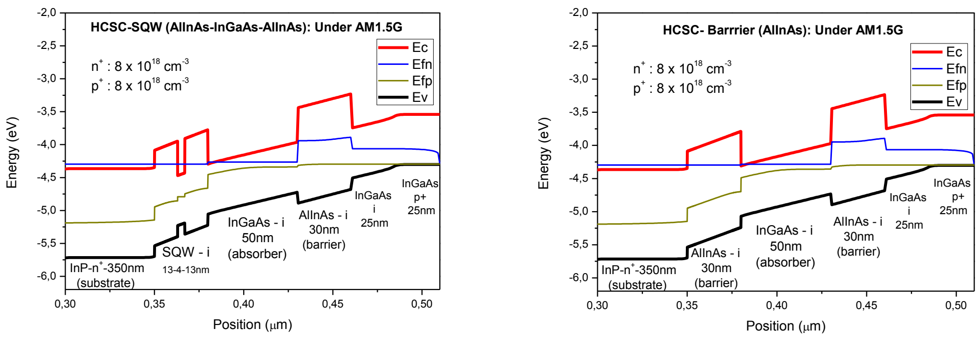

Fig. 1 Electronic band diagram of the simplified HCSC structure with a SQW/Barrier under AM 1.5G illumination under equilibrium, without contact.

[1] R. T. Ross et al.. “Efficiency of hot-carrier solar energy converters.” J. Appl. Phys. 53(1982) 3813-3818.