Nanoscale analyses of axial III-V nanowires for solar cells

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The record in photovoltaic conversion efficiency is detained by multi-junction solar cells based on III-V semiconductors. However, the wide adoption of these devices is hindered by their high production cost, to a large extent due to the expensive III-V substrates. As an alternative, a hybrid geometry has been proposed [LaPierre JAP 2011], which combines a 2D Si bottom cell with a III-V nanowire top cell in a tandem device. This approach, which may reach theoretical efficiencies of approx. 34%, requires smaller amounts of expensive III-V materials compared to conventional III-V tandem cells and benefits from the nanowire light trapping effects.

In this work, we report the fabrication and nanoscale characterization of nanostructures for solar cells: namely, axial GaAsP p-n junction nanowires. Nanowires are grown by gallium-assisted molecular beam epitaxy using Be and Si as doping sources. The composition (probed by EDX and cathodoluminescence) was adjusted to tune the bandgap toward the optimal value for a III-V-on-Si tandem cell (approx. 1.7 eV). Local I-V characteristics and electron beam induced current (EBIC) microscopy under different biases are used to probe the electrical properties and the generation pattern of individual nanowires. The doping concentrations and the minority carrier diffusion lengths were extracted from the EBIC generation profiles (see figure 1). The effect of an epitaxial GaP passivating shell on the optical and generation properties was assessed.

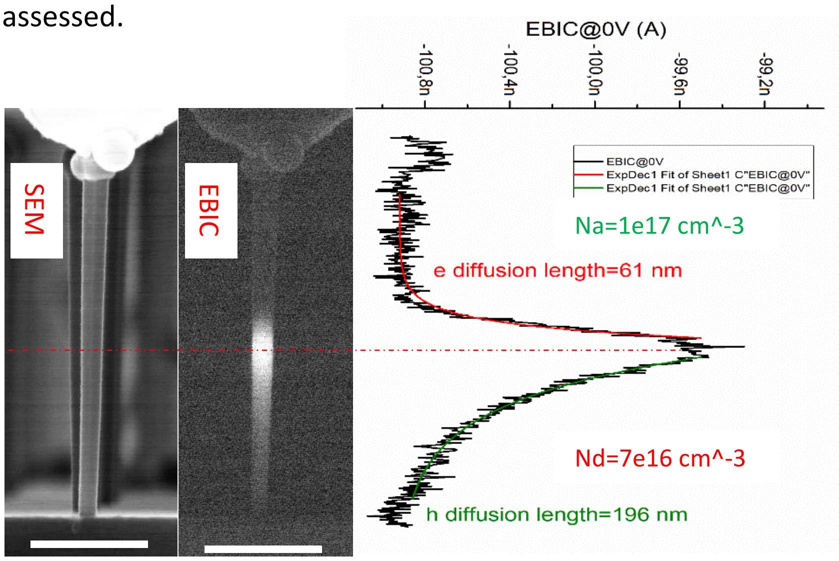

Figure 1: EBIC map of a single GaAsP NW containing an axial p-n junction and the corresponding SEM image at Vbias=0V

LaPierre, JAP, **110**, 014310, 2011) and Bu 34.3 % (Bu et al., APL, **102**, 031106, 2013).