# Core-shell AlGaAs nanowires for high efficiency tandem solar cells on Si

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Increasing competitiveness of photovoltaic (PV) devices is currently an important objective in technological research and since fabrication costs of PV modules now tend to stabilize, improvement is achievable only by augmenting module efficiency. Since theoretical calculations show that coupling III-V materials and Si allows to raise the maximum limit up to 42 % [1], efforts have been made to develop tandem solar cells (i.e. cells obtained by coupling two different units, a top and a bottom one) based on III-V/Si layers. Nevertheless these devices led to poor performances because of the high lattice mismatch [2], while the right approach to overcome this drawback seems to be the fabrication of III-V nanowires (NWs) based tandem cells, since NWs small footprint and strain accommodation allows synthesizing these structures even on highly mismatched substrates.
HETONAN ANR project originated in such context with the aim of fabricating a top cell made of a regular array of p/n core-shell $Al_{0.2}Ga_{0.8}As$ NWs directly grown via self-catalysed vapour-liquid-solid (VLS) MBE on a planar Si bottom cell (Fig. 1a). NWs composition and geometry were theoretically calculated to optimize light absorption in the device.

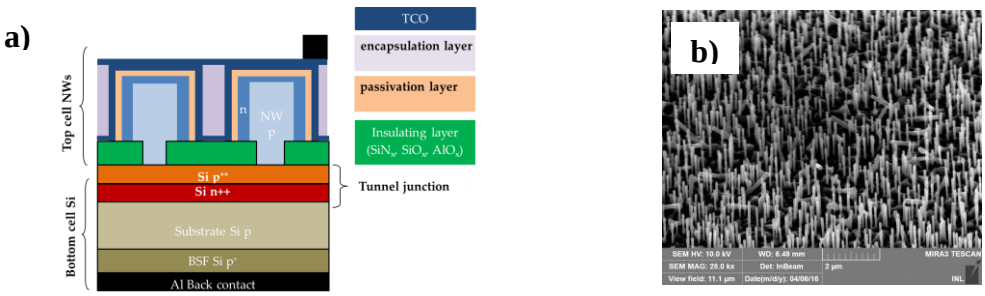


Fig. 1: a) Representation of the final structure we expect to obtain for the tandem solar cell. b) SEM image of self-catalysed p/n core-shell GaAs/AlGaAs NWs grown on Si(111).

Regarding experimental results, the first part of our work concerned the synthesis of self-catalyzed p-n core/shell GaAs/AlGaAs NWs, i.e. the optimization of growth parameters to obtain good NWs in terms of density, morphology and crystalline structure (Fig. 1b). NWs were characterized by electron beam induced current microscopy (EBIC), photoluminescence and TEM measurements. The next step consists in the growth of $Al_{0.2}Ga_{0.8}As$ NWs, a task which is still under development and appears more challenging because of the presence of Al, since this metal tends to reduce the silicon dioxide present on the substrate surface leading to stable aluminium oxides. Once this objective is fulfilled we will try to reproduce these structures on patterned substrates in order to obtain regular arrays of NWs.

**References**

[1] J. P. Connolly, D. Mencaraglia, C. Renhard and D. Bouchier, *Progress in Photovoltaics: Research and Applications*, **22**, 810 (2014)
[2] N. Jain and M. K. Hudait, *Energy Harvesting and Systems*, **1**, 121 (2014)