Shell material assessment for GaAs-based nanowire solar cells

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Abstract

Nanowire (NW) solar cells are an innovative and promising way to further reduce the cost of photovoltaic electricity for terrestrial applications, due to their efficient light absorption and significant cost reduction [1], [2]. A record NW solar cell efficiency value of 15.3% has been recently published for a GaAs-based NW device, with a volume of GaAs equivalent to a 370-nm thick planar layer [3].

So far, all high performance NW solar cells have been grown axially with Au-mediated vapour-liquid-solid (VLS) method in MOVPE [3], [4]. However, due to the high density of surface states in GaAs, an additional growth of a radial shell material must be included after NW growth to passivate its surface, as in any GaAs-based NW electronic device. In particular for GaAs-based NW solar cells, the shell material should be transparent to the incident light (i.e., higher energy bandgap than GaAs) and should not introduce any strain (i.e., lattice-matched composition to GaAs) to avoid optical and electrical losses, respectively.

In this work, several candidate materials to be employed as shells for GaAs NW solar cells are assessed, namely AlGaAs, GaInP and AlInP. Intrinsic GaAs core NWs were firstly grown by the VLS-MOVPE method on GaAs(111)B substrates with a Au pattern defined by nano imprint lithography. Subsequently, the shell material was grown in the same reactor without removal of the Au particle. Shell materials were grown at different temperatures, growth rates and lattice-matching composition. Fig.1 (a) shows as an example a cross section SEM image of GaAs NWs with a 35 nm thickness GaInP shell. Fig.1(b) shows the PL measurement at RT of GaAs NWs with and without a lattice-matched 15 nm thickness AlInP shell, where a 60 fold increase in the room temperature ensamble PL signal can be observed. The full morphological, structural and optoelectronical characterization will be presented in the final contribution to the conference.

References

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Figures

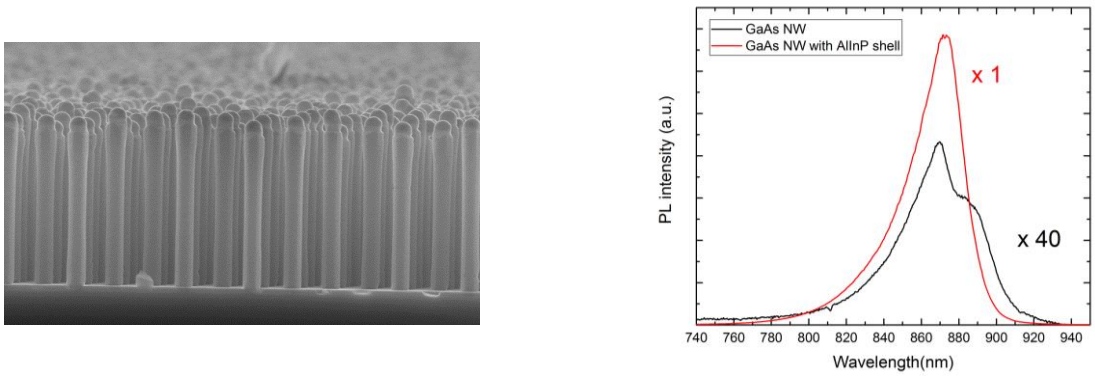

Fig.1 (a) SEM image of GaAs NWs with GaInP shell (b) RT PL ensemble of GaAs NWs with and without AlInP shell.