Broken gap core-shell heterostructure nanowires

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Core-shell nanowires are promising structures for future optical and electronic applications. In this context, several material combinations have been investigated showing for example enhanced photoluminescence intensity in GaAs/AlGaAs core-shell nanowires [1] and periodic magnetoconductance oscillations in GaAs/InAs core-shell nanowires [2]. However, in both cases only one material plays an active role in the device while the second one solely acts as a passivation layer or host material. Heterostructures with InAs and GaSb are interesting as the InAs shows n-type conductivity while the GaSb is p-type. Additionally, the heterojunction is of type III, i.e. having a broken gap. Recently, GaSb/InAs core-shell nanowires have been investigated [3] and the reverse structure was theoretically studied by Kishore et al. [4]. However, the growth of these InAs/GaSb core-shell nanowires has not yet been explored.

Here, we present the growth of InAs/GaSb core-shell nanowires using molecular beam epitaxy. The growth is performed without a foreign catalyst on Si (111) substrates. Fig. 1 (a) shows the HAADF profile and the EDX counts for Ga and In in such a core-shell nanowires. We shall show that during overgrowth, the {110} sidefacets of the InAs core develop into {211} sidefacets of GaSb as schematically shown in Fig. 1 (b). The core-shell geometry can be clearly seen. As expected from the low mismatch of less than 1 %, no misfit dislocations are formed.

In a second experiment, these InAs/GaSb core-shell nanowires are overgrown with an additional layer of InAs. Preliminary results indicate that the InAs grows preferentially on the remaining {110} facets resulting in six separated InAs nanowires surrounding the InAs/GaSb core-shell structure as schematically depicted in Fig. 1 (c).

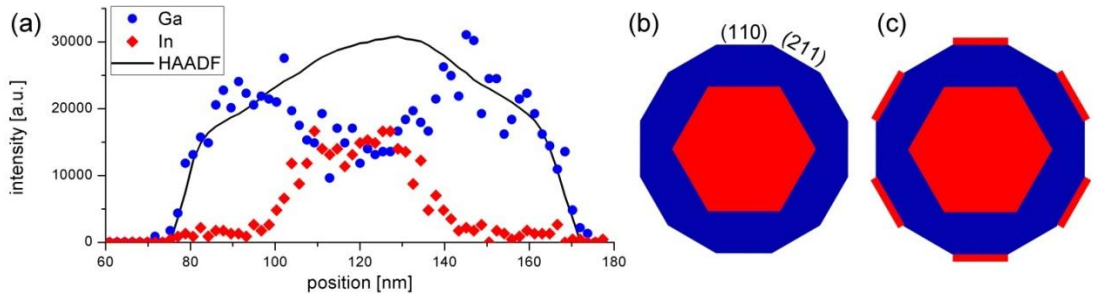

Fig. 1: (a) EDX profile along an InAs/GaSb core-shell nanowire, (b) schematic view of an InAs/GaSb core-shell nanowire and (c) schematic view after overgrowth with InAs

[1] O. Demichel et al., Applied Physics Letters 97, 201907 (2010).
[2] Ch. Blömers et al., Nanotechnology 24, 035203 (2012).
[3] B. Ganjipour et al., Applied Physics Letters 101, 103501 (2012).
[4] V.V.R. Kishore et al., Physical Review B 86, 165439 (2012).