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Supporting Information

Nanowire morphology:

SEM image of GaAs/GaSb/$Ga_xIn_{1-x}Sb$ nanowires grown at 550 °C with highest possible Ga/In vapor phase ratio in our system. The compositional analysis performed on these nanowires indicated almost no In content (pure GaSb) nanowires terminated with almost pure Ga droplets on the top of the nanowires.

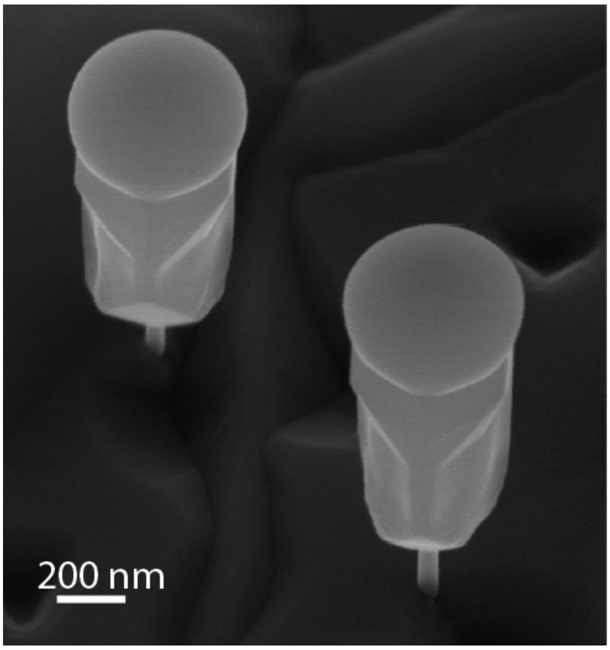

Figure S1. 30^o tilted SEM image of 50 nm Au seeded GaAs/GaSb/$Ga_xIn_{1-x}Sb$ nanowires grown at 550 °C with highest Ga/In vapor phase ratio of 235, demonstrating dramatic diameter change (~1 order of magnitude) from the bottom GaAs segment to the top part.

Modeling:

This model considers two parallel pathways for the corresponding two group III precursors (TMGa and TMIn). Considering TMIn precursor, the following rate equations (equations 1-3) relates the In concentration at different states including precursor (P), vapor (V), liquid (L), and solid (S) with the corresponding rates, as shown in figure S2.

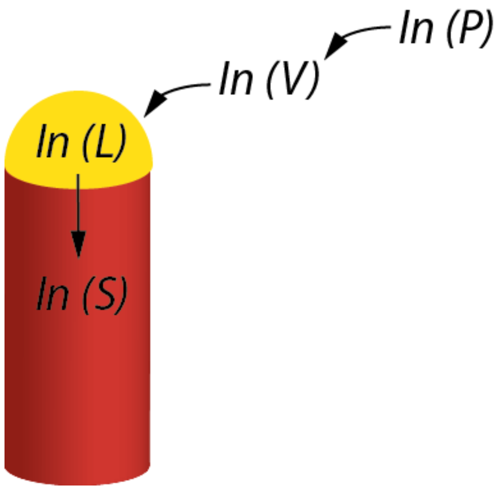

Figure S2. The pathway for the precursor TMIn at different states including precursor (P), vapor (V), liquid (L), and solid (S). The same pathway exists for TMGa precursor (not shown here).

$$In\ (P) \rightarrow In\ (V),\quad k_P^{In\,V} \qquad (1)$$

$$In\ (V) \rightarrow In\ (L),\quad k_V^{In\,L} \qquad (2)$$

$$In\ (L) \rightarrow In\ (S),\quad k_L^{In\,S} \qquad (3)$$

Assuming first order processes, we arrive at the following rate equations:

$$\frac{d[In]^V}{dt} = k_P^{In\,V}[In]^P - k_V^{In\,L}[In]^V = 0 \qquad (4)$$

$$\frac{d[In]^L}{dt} = k_V^{In\,L}[In]^V - k_L^{In\,S}[In]^L = 0 \qquad (5)$$

$$\frac{d[In]^S}{dt} = k_L^{In\,S}[In]^L \qquad (6)$$

where we have assumed steady state concentrations of In in the vapor and in the particle (equations 4 and 5). Combining equations 4-6 results in:

$$k_L^{In\,S}[In]^L = k_V^{In\,L}[In]^V = k_P^{In\,V}[In]^P \qquad (7)$$

The nanowire In composition (X_S^{In}) can now be expressed as:

$$X_S^{In} = \frac{\frac{d[In]^S}{dt}}{\frac{d[In]^S}{dt} + \frac{d[Ga]^S}{dt}} = \frac{k_P^{In\,V}[In]^P}{k_P^{In\,V}[In]^P + k_P^{Ga\,V}[Ga]^P} \qquad (8)$$

As the $k_P^{In\,V}$ and $k_P^{Ga\,V}$ are rates for activated processes, they are given by Arrhenius expressions (9-10).

$$k_P^{In\,V} = k_0^{In}\, e^{\frac{-E^{In}}{RT}} \qquad (9)$$

$$k_P^{Ga\,V} = k_0^{Ga}\, e^{\frac{-E^{Ga}}{RT}} \qquad (10)$$

Substituting equations 9 and 10 into the equation (8) results in:

$$X_S^{In} = \frac{[In]^P}{[In]^P + k' \exp(-E/RT)[Ga]^P} \qquad (11)$$

Where $k' = \frac{k_0^{Ga}}{k_0^{In}}$ and $E = E^{In} - E^{Ga}$

Equation (11) could be rewritten in the following way to obtain the activation energy (E) and pre-exponential factor (k'):

$$\frac{\frac{[In]^P}{X_S^{In}} - [In]^P}{[Ga]^P} = k' \exp(-E/RT) \qquad (12)$$

by plotting the logarithm of the left hand side of equation (12) as a function of 1/T.

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Particle composition:

The Sb/Au ratio for samples grown at various temperatures with highest Ga/In vapor phase ratio (235) is shown in figure S3. The data suggest lower Sb/Au ratio for samples grown at higher temperatures.

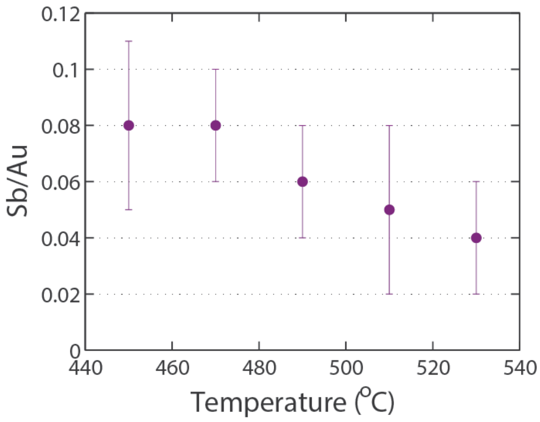

Figure S3. Sb/Au ratio for nanowires grown with highest Ga/In vapor phase ratio (235) with various temperatures from 450-530 °C, demonstrating lower Sb/Au for higher temperatures.

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Growth rate:

The growth rate of the $Ga_xIn_{1-x}Sb$ nanowires grown at 510 °C with medium Ga/In vapor phase ratio (91) indicate a very low growth rate of ~3nm/min.

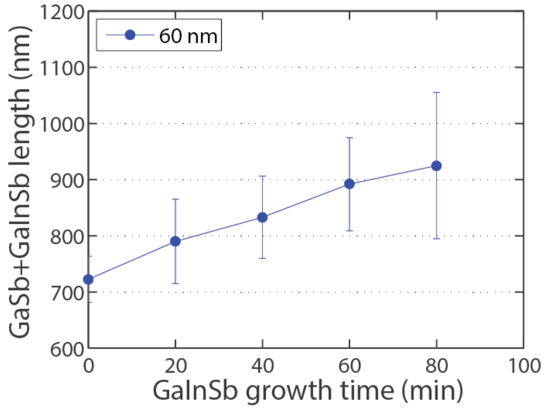

Figure S4. Measured length for both GaSb and $Ga_xIn_{1-x}Sb$ segments with respect to the growth time (20-80 min). The nanowires are seeded with 60 nm Au nanoparticles and are grown at 510 °C with medium Ga/In vapor phase ratio (91).