Supplementary information for: "**Controlling the morphology, composition and crystal structure in gold-seeded $GaAs_{1-x}Sb_x$ nanowires**"

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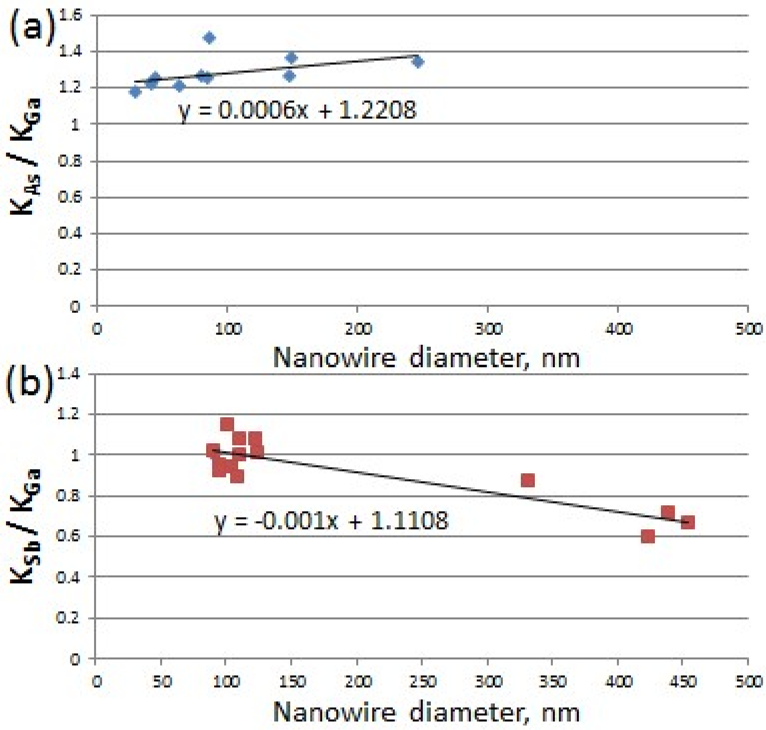

Fig. S1 K_{As} and K_{Sb} for nanowires with various diameters: (a) GaAs and (b) GaSb. Both GaAs and GaSb reference nanowire samples are taper free with zinc blende twin free structure. The K-factor is calibrated using the L-line for Ga As and Sb. K_{Ga} is chosen as a reference and fixed at 1. K_{As} increases slightly with nanowire diameter while K_{Sb} reduces with diameter. The dependence of K-factor with nanowire diameter is fitted with a linear equation and is shown as using a solid line in the graph.

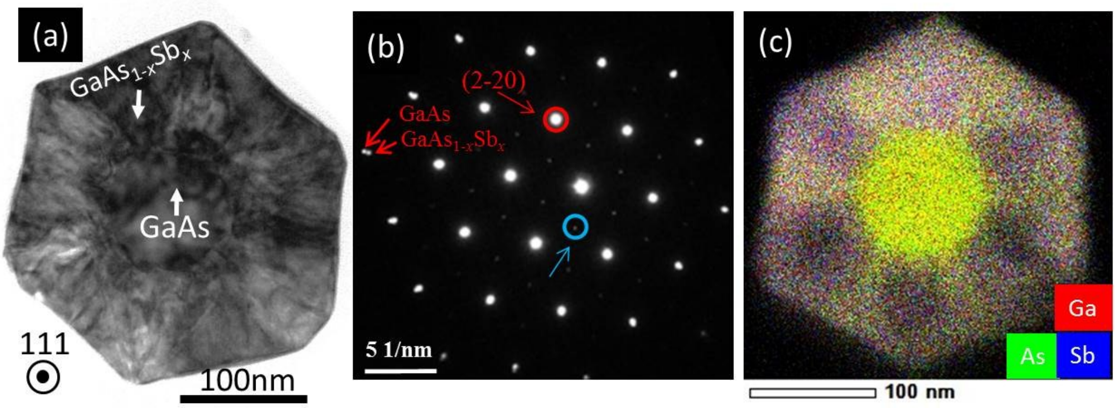

Figure S2 TEM and EDX mapping of the cross section at the GaAs stem. (a) TEM images along the [111] zone axis showing the GaAs core and the surrounding $GaAs_{1-x}Sb_x$ shell. (b) Corresponding diffraction pattern in (a). {110} Diffraction spots of GaAs core and $GaAs_{1-x}Sb_x$ shell could be seen. In addition, the spots marked by blue arrow comes from the streaking effect due to {111} twin defects, as reported by Den Hertog et. al[1]. EDX mapping clearly shows the GaAs core surrounded by an $GaAs_{1-x}Sb_x$ shell. A 30° rotation between the facets of the core and shell is observed in both the TEM image and the EDX map. The contrast in the shell is due to a combination of composition and thickness difference.

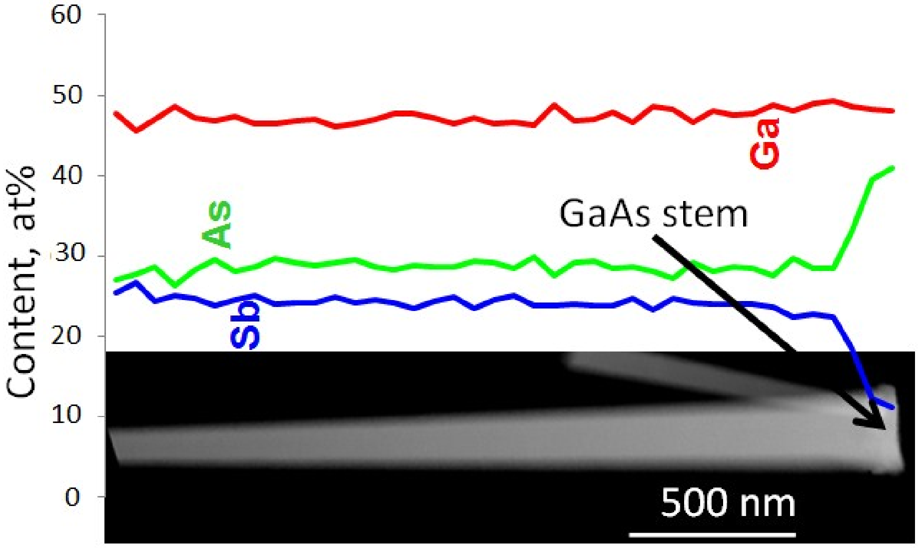

Fig. S3. EDX line scan results of another $GaAs_{1-x}Sb_x$ NW grown under the same growth conditions, which shows the Sb profile decreasing slightly from tip to base. This composition distribution profile along the nanowire agrees with our EDX analysis of the cross section sample in Fig.1d.

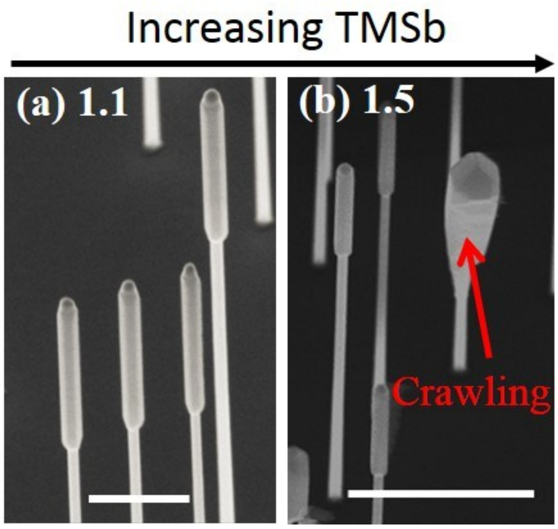

Figure S4 SEM images of GaSb NWs on GaAs stem. Growth condition for GaSb is 500 °C and TMGa=$0.6*10^{-5}$ mol/min. (a) GaSb NWs grow non-tapered with (1-10) side facets. Increasing TMSb flow could cause GaSb to crawl back to the GaAs stem. Scale bars are 1μm.

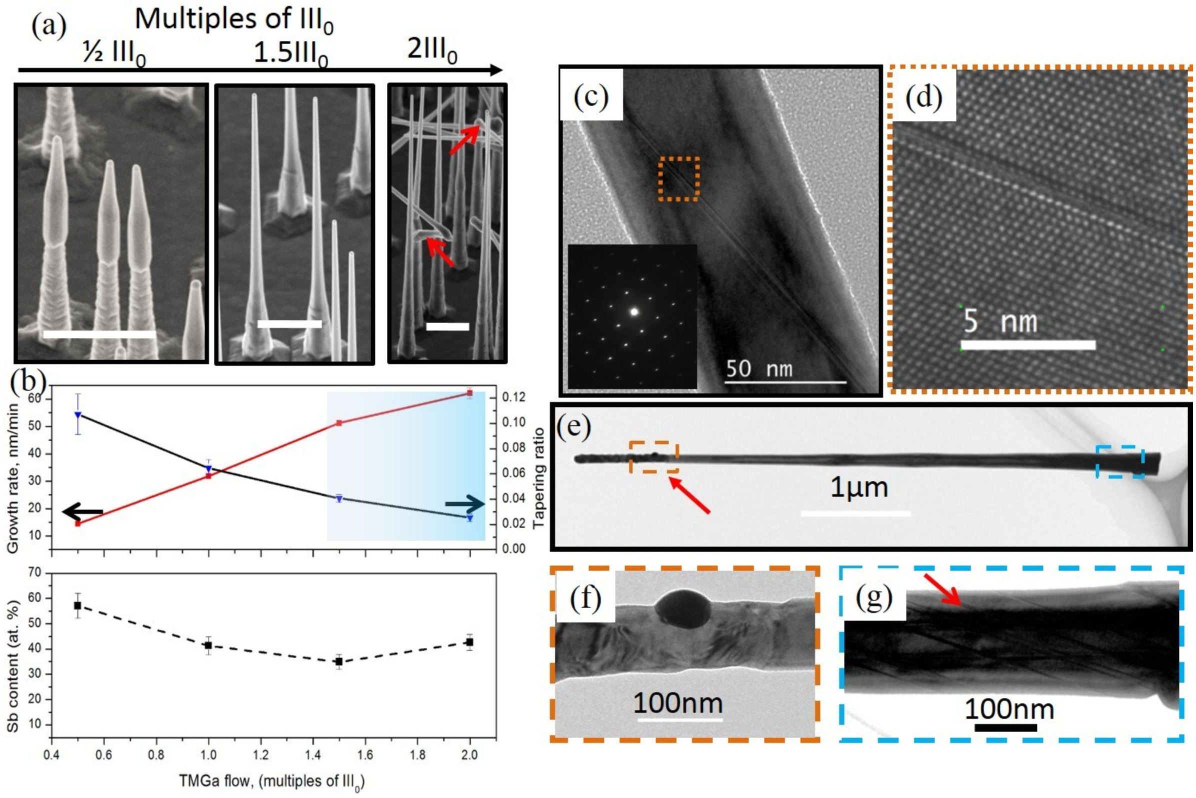

Figure S5 Influence of precursor flow on the morphology, composition and crystal structure of $GaAs_{1-x}Sb_x$ NWs. AsH_3/TMGa and TMSb/TMGa were fixed at 0.75. (a) 45° tilted SEM images of NWs with various precursor flow: 0.5, 1.5 and 2 of III_0 (TMGa=1.2×10^{-5} mol/min). About 17% NWs are non-vertical when precursor flow increases to $2III_0$. (b) Axial growth rate increases nearly linearly with precursor flow and tapering ratio also drops consistently. The Sb content change in the NW is much smaller. It drops slightly with increasing precursor flow but increases at $2III_0$ flow. (c) TEM image of a NW grown with $1.5III_0$ showing the existence of inclined stacking faults. Inset is the corresponding SADP. (d) HRTEM image of the stacking faults marked in (c) confirms the existence of stacking faults. (e-g) show a NW grown with $2.0III_0$ with the Au droplet at the sidewall of NW and inclined defects at the bottom of the $GaAs_{1-x}Sb_x$ NW. The observation of Au seed on the sidewall of NW is evidence that the Au seed could dislodged from the growth front to wet the sidewall and form inclined defects. The cyan region in (b) indicates the condition where non-vertical NWs exist, the deeper the colour, the higher percentage of non-vertical NWs.

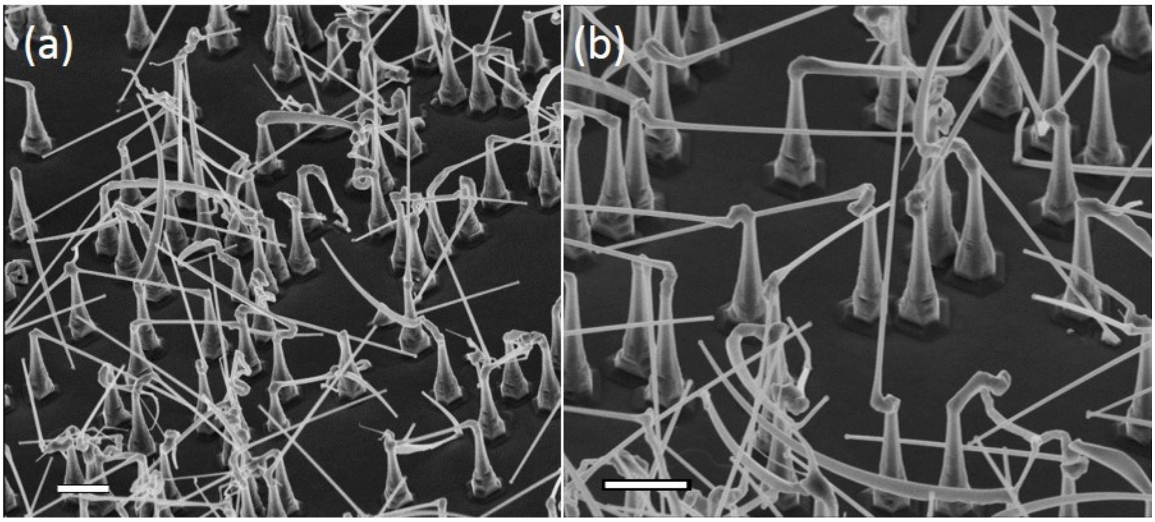

Figure S6 Morphology of sample #8, (a) with a grading layer grown for 8 min, (b) without grading layer. The grading layer consists of the following two steps. Firstly, $GaAs_{1-x}Sb_x$ NWs with condition of reference sample is grown for 3 min after switch from GaAs to $GaAs_{1-x}Sb_x$ NWs. Then the AsH_3 and TMSb flows are gradually increased over 5 min to the final growth condition as sample #8. The morphology of NWs with and without grading layer is similar, indicating that the grading layer is not helpful to increase the yield of vertical nanowires. Scale bars are 1μm.

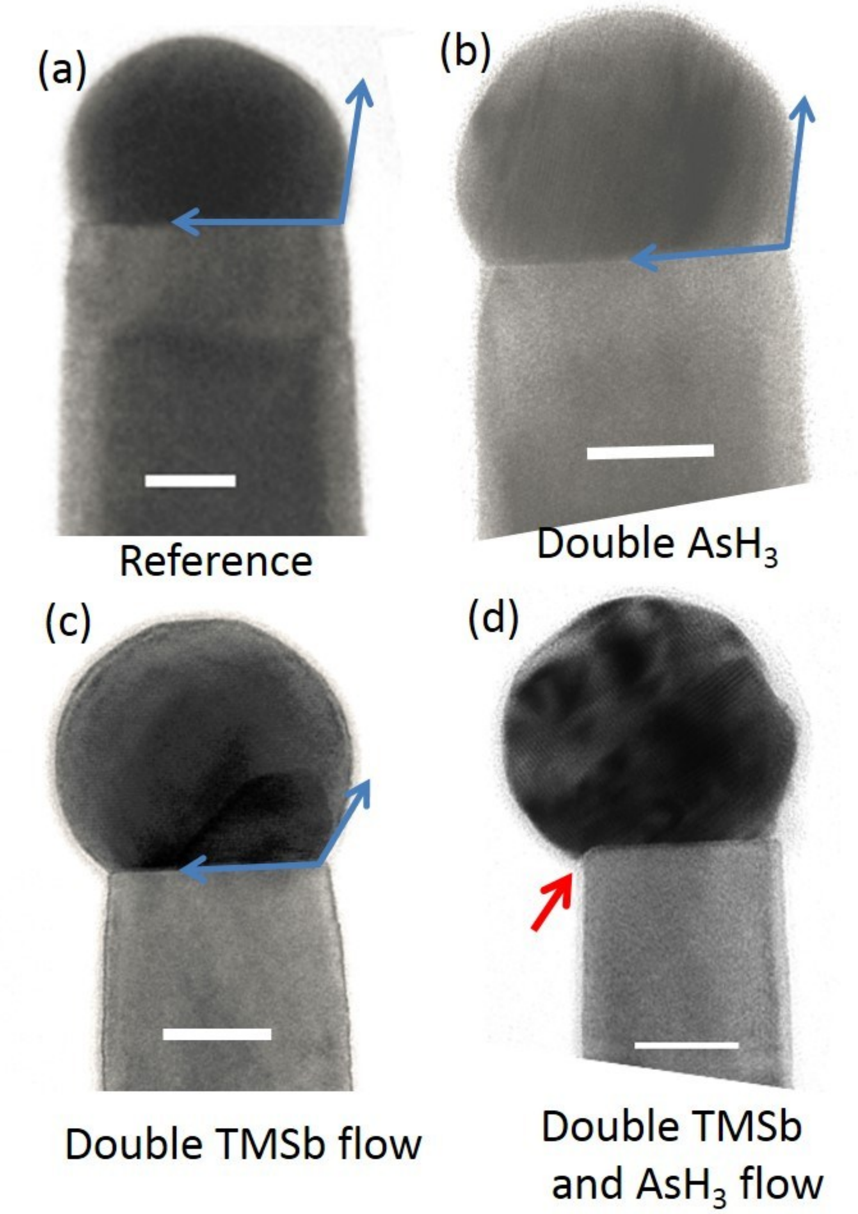

Figure S7 Bright field TEM images of the Au particles along the [1-10] zone axis showing their wetting configuration after being cooled down under the same condition, AsH_3=1.8*10^{-5} mol/min, TMSb=1.8*10^{-5} mol/min: reference sample (a), double AsH_3 flow (b) double TMSb flow (c) and double both TMSb and AsH_3 flow (d). The wetting angle in (c-d) is clearly larger than that in (a-b), which suggests the cooling down condition does not affect the wetting configuration in our case. In addition, the Au particle wets the sidewall of NW as indicated in (d), which provides an evidence that it can be dislodged from the growth front to wet the sidewall of NW and form inclined defects. Scale bar in the figure is 20 nm.

Reference:

1 C. Cayron, M. Hertog, L. Romain, C. Mouchet, C. Secouard, J. Rouviere, E. Rouviere and J. Simonato, Journal of applied crystallography, (2009), 42, 242-252.