Electronic Supplementary Material (ESI) for Nanoscale
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Supporting Information

Hybrid Axial and Radial Si/GaAs Heterostructures in Nanowires

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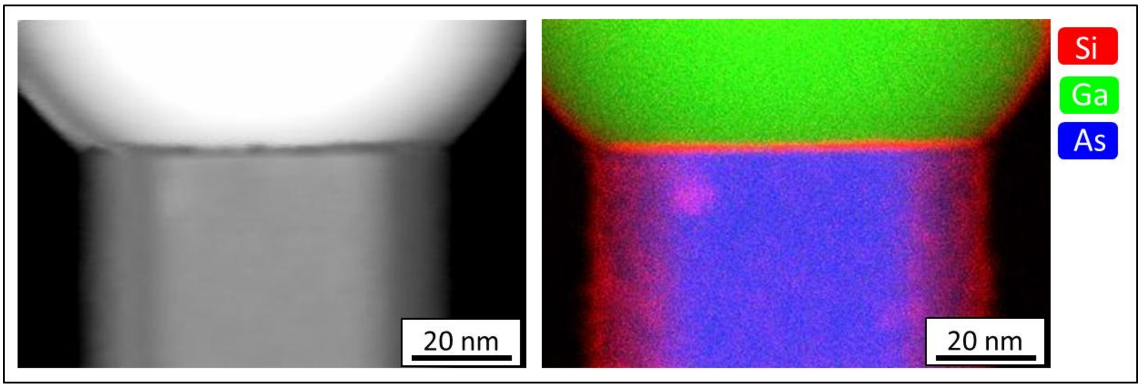

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As shown in Figure 1 of the main manuscript, one can distinguish two different regions in the PECVD parameter space. The first region, marked in yellow, represents the parameter space leading to amorphous silicon incorporation into the GaAs nanowires, and corresponds to the high-temperature (300 ^{o}C) and low silane flow rate (ranging from 10 to 20 sccm) regime. For these conditions, we observe that amorphous silicon is deposited homogeneously on the nanowire/droplet system, resulting in an uniform shell with thicknesses ranging from 6 to 10 nm, as can be clearly seen in Figure S1.

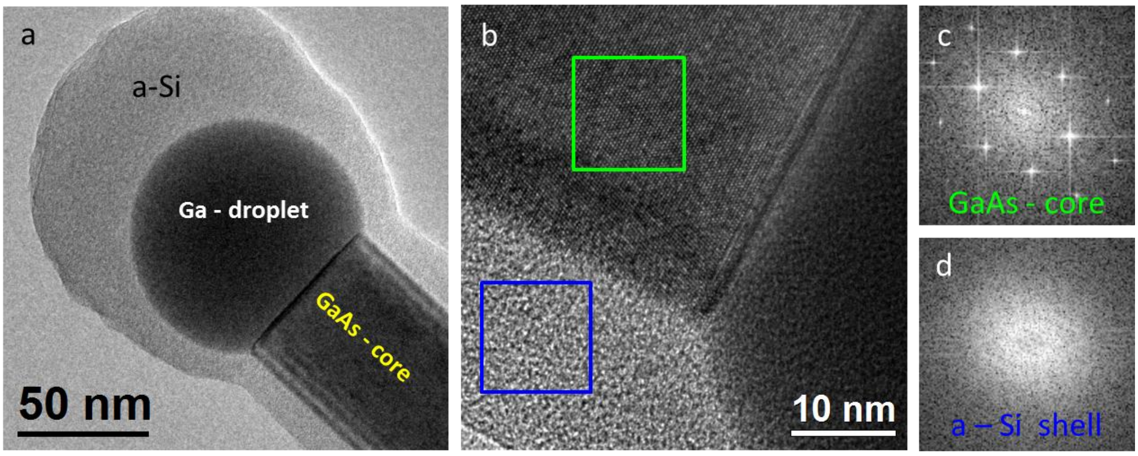

Figure S1.(a) BF TEM image showing a representative GaAs nanowire covered by amorphous Si layer after PECVD deposition. (b) HRTEM image in which the crystalline GaAs core and amorphous silicon shell is clearly visible as we can confirm by the diffraction pattern in (c) and (d), respectively.

One of the interesting features observed for some of the growth conditions is the preferential accumulation of a-Si:H at the upper part of the droplet, in particular at low silane flow rates. Such preferential deposition structure might be related to the incomplete reduction of the Ga droplet during the pre-treatment with hydrogen plasma. As a consequence, the nanowire concentrates the electrical field of the plasma leading to the observed preferential deposition due to the tip effect. For a temperature of 300 ^{o}C, the atomic hydrogen tends to absorb much less efficiently on the surfaces leading to a diminishing effect of the oxide reduction, as shown in the Figure S2.

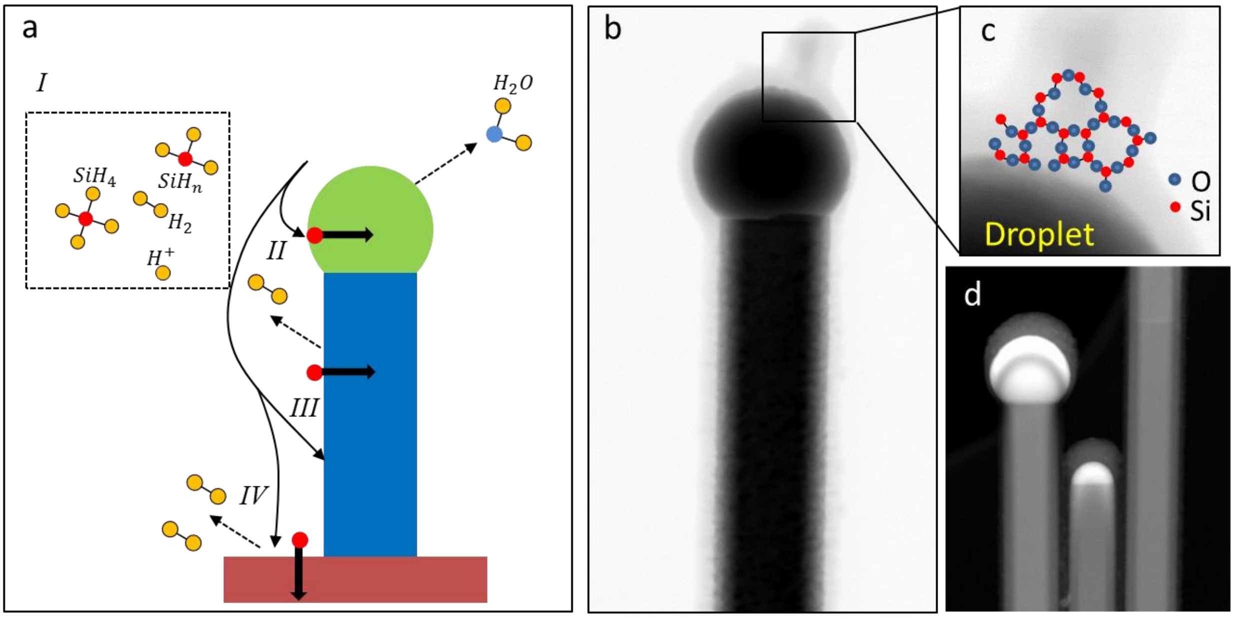

Figure S2. (a) Schematic illustration of the transport processes during deposition: (I) uncatalyzed homogeneous decomposition of molecule; (II) adsorption and catalytic decomposition of the species on the catalytic droplet; (III) and (IV) adsorption and uncatalyzed deposition of amorphous or crystalline or polycrystalline silicon on the sidewalls and substrates, respectively; (b)-(d) BF and HAADF images showing the preferential accumulation of a-Si at the tip of the droplet, in (c) schematic illustration of this effect.

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Keeping the same temperature of 250 ^{o}C but increasing the silane flow rate to 20 sccm we observe the presence of nano-crystalline silicon grains on the sidewalls of the nanowire, shown as red spots in Figure 3h of the main manuscript. The size of these nano-crystalline silicon grains ranges between 8 and 10 nm, as seen in Figure S3. These silicon grains might arise from nanoparticles created in the gas phase.

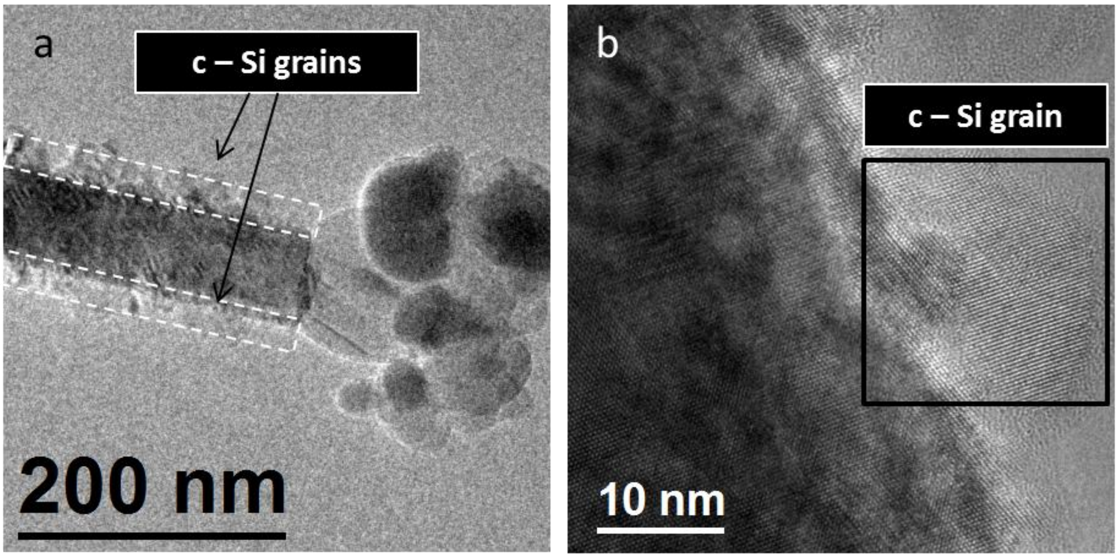

Figure S3. (a) Low magnification TEM image exhibiting the presence of c-Si grains on the sidewalls of the nanowire. (b) Magnification of the lateral of the nanowire showing a crystalline Si grain with size around 10 nm.

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