

Sn-doping effect on the structure of GaAs nanowires grown by MOCVD

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III-V nanowires (NWs) are promising building blocks for electronic and optoelectronic devices. As one of the most developed III-V NWs, GaAs NWs have the suitable bandgap for new generation solar cells. To achieve this application, it is necessary to form p-n junction(s) in GaAs NWs. Consequently, different impurities have been utilized as dopants in the last decade. However, the addition of impurity dopants can affect the nanowire crystal structure and morphology. Hence it is crucial to study this effect so as to be able to achieve controllable growth. Sn has been investigated as an n-type dopant for III-V NWs [1, 2] and recently was used as n-type dopant in GaAs NW array solar cells with high conversion efficiency [3]. However, there has been only limited studies regarding the effect of Sn addition on GaAs NW morphology and structure [1, 2, 4]. In this study, we systematically investigated the effect of TESn addition on the structure of GaAs NWs grown by metal organic chemical vapour deposition (MOCVD).

Figure 1 shows the SEM images taken from undoped and Sn-doped GaAs NWs, in which the NW axial growth was suppressed remarkably while lateral growth was promoted with increasing TESn flow rate. Figure 2 is TEM image taken from undoped and highly Sn-doped (TESn/TMGa=2) GaAs NWs that shows Sn doping degraded the crystal quality by introducing planar defects in the NWs. Figure 3 shows the catalyst composition of as-grown NWs. The phase change from Au-Ga to Au-Sn suggests that Sn could compete with Ga to alloy with Au during the NW growth, resulting in a lower growth rate and affecting the crystal quality.

References

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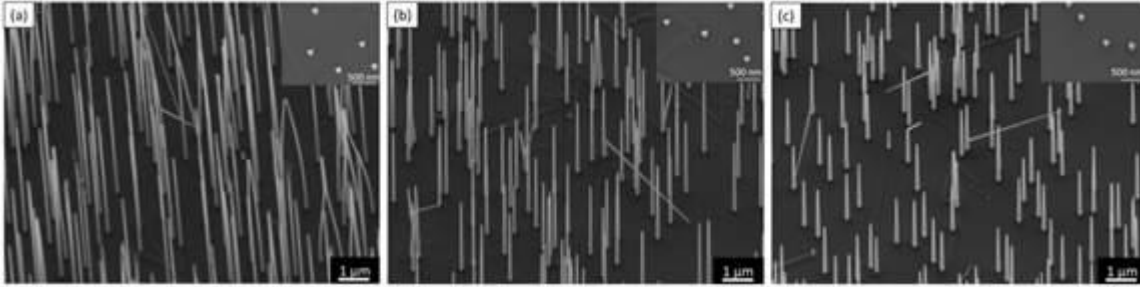


Figure 1 Tilted-view SEM images of vertical aligned GaAs NWs with varying amount of Sn incorporation: (a) undoped, (b) TESn/TMGa = 1, (c) TESn/TMGa = 2. Insets are top-view of corresponding samples.

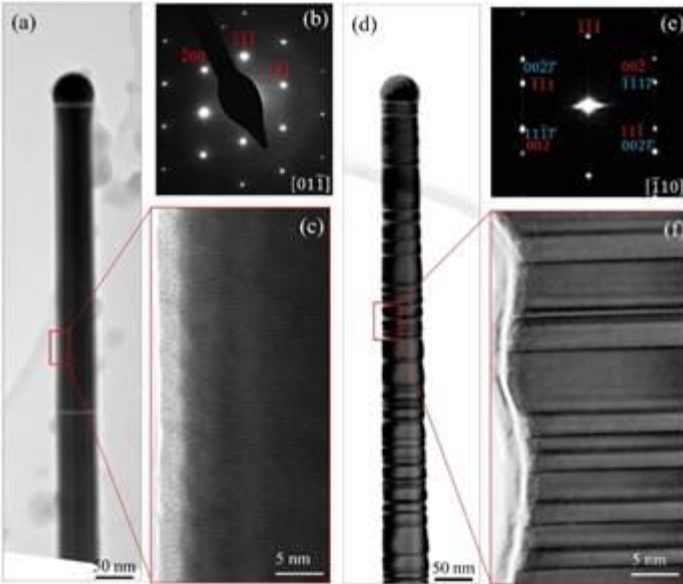


Figure 2 Bright-field TEM images of the top section of (a) undoped and (d) doped (TESn/TMGa = 2) GaAs NWs. (b, e) $\langle 110 \rangle$ -zone-axis electron diffraction patterns and (c, f) HRTEM images of marked area in (a) and (d), respectively.

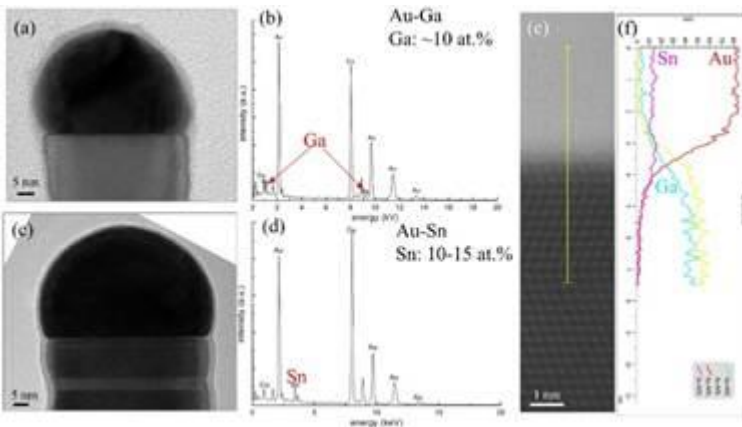


Figure 3 Analysis of NW catalyst without (a, b) and with high Sn addition (c, d). (a, c) are TEM images of at the tip of the NWs. (b, d) are EDS profiles taken from the catalysts. Atomic-level HAADF image (e) showing the catalyst-NW interface region of the highly doped NW, and (f) is the corresponding EDS line-scan.