Study of Conduction Mechanism using Temperature-Dependent Current-Voltage Measurements for GaAsSb Nanowire and Effect of In-situ Annealing.

Mehul Parakh[1], Sean Johnson[2], Rabin Pokharel[1], Shisir Devakota[1], Priyanka Ramaswamy[2], Jia Li[1] and Shanthi Iyer[1, 2 *]

[1]Nanoengineering, Joint School of Nanoscience and Nanoengineering, North Carolina A&T State University, Greensboro, North Carolina 27401, USA.
[2]Department of Electrical and Computer Engineering, North Carolina A&T State University, Greensboro, North Carolina 27411, USA.

This work presents the first observation of space charge limited conduction (SCLC) mechanism in intrinsic GaAsSb nanowires (NW) grown by Ga-assisted molecular beam epitaxy and the effect of post-growth in-situ annealing in an ultra-high vacuum on the conduction mechanism in the NWs. Current-voltage (I-V) measurements on single NW (using Conductive Atomic Force Microscopy) and ensemble NWs (using two probe method) exhibited linear behavior at lower bias transitioning to a power law behavior at higher bias, where the dominance of injected carriers over thermally generated charge carriers was observed. Temperature-dependent analysis on as-grown ensemble NW device in SCLC region yielded a wide trap density of 10^{16} cm^{-3} distributed over a wide energy range in the band gap compared to the reduced trap density of $7 * 10^{14}$ cm^{-3} in in-situ annealed NW ensemble at a trap energy level of 0.12 eV located below the band edge, suggesting annealing in ultrahigh vacuum is an effective approach for the annihilation of the traps. The trap density is attributed to be originating from Ga vacancy and GaSb defect level in III-V ternary material system. Increased PL intensity and red shift with reduced full-width half maxima at 4K were observed for in-situ annealed NWs compared to as-grown NWs. This can be correlated to better compositional homogeneity and annihilation of traps in the annealed NWs. Asymmetrical broadening and decreased TO/LO mode observed in the room temperature Raman spectra of as-grown NWs correlates well to more strain incorporation and presence of disorder, leading to the higher density of traps compared to the in-situ annealed NWs.

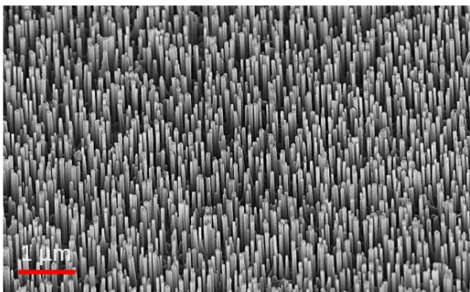

Figure 1. SEM image of GaAsSb NWs on Si<111> substrate.

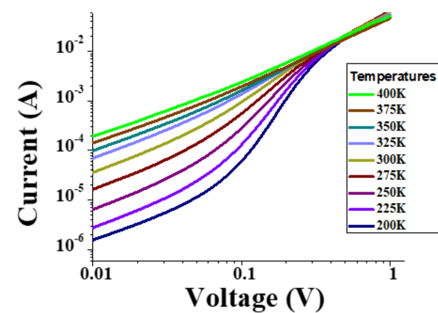

Figure 2. Temperature dependent I-V Characteristics for in-situ annealed GaAsSb NWs.

+Corresponding author email: iyer@ncat.edu

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Supplementary Pages (Optional)

Different conduction mechanisms in in-situ annealed and as-grown ensemble GaAsSb NWs.

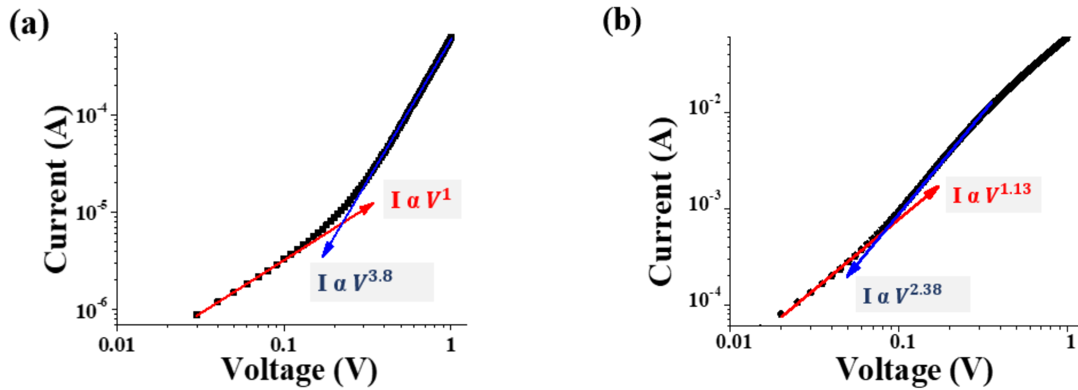

Figure S1. (a) Log-log I-V plot for the as-grown and, (b) annealed NW ensemble devices at room temperature exhibiting linear and power dependence.

Comparison of current mapping for as-grown and in-situ annealed NWs using C-AFM.

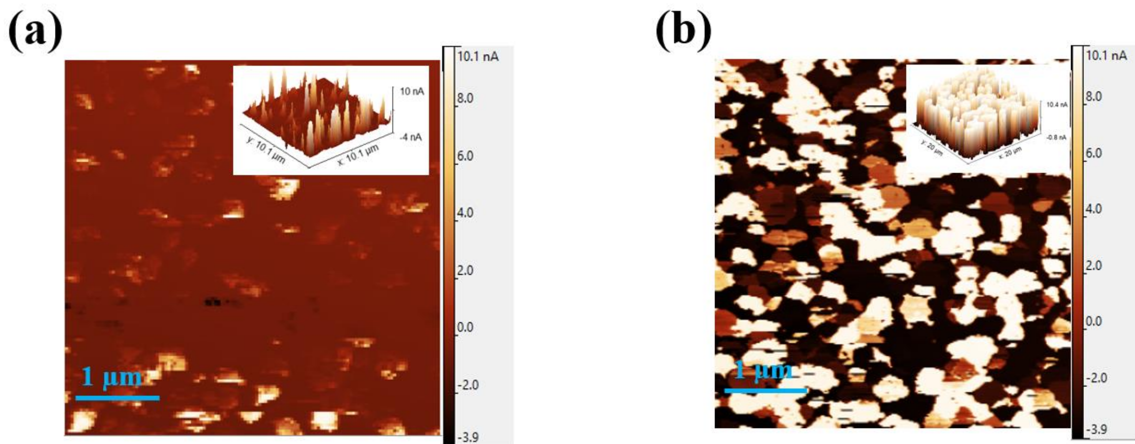

Figure S2. (a) Current mapping for the as-grown NWs using C-AFM (inset: 3D current mapping), (b) current mapping for in-situ annealed NW ensemble (inset: 3D current mapping).