Electronic Supplementary Information

Investigating the Mechanical Properties of GeSn Nanowires

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Energy dispersive X-ray analysis data for GeSn nanowire composition

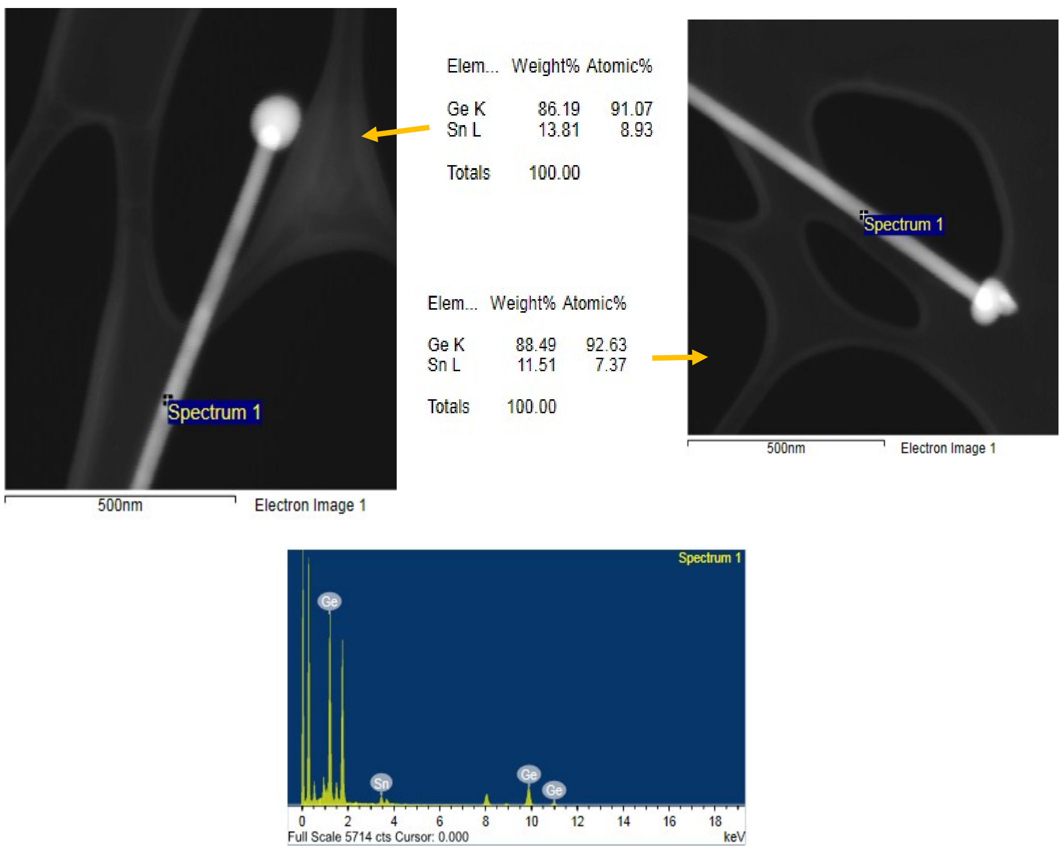

Figure S1: Representative EDX point analysis from two different GeSn nanowires showing Sn inclusion of 8.9 and 7.4 at. %. Corresponding EDX spectra is also attached for GeSn nanowire with 7.4 at.% nanowire

Calculation example for composite Young's modulus from a core-shell nanowire model

A simple core-shell model formula for composite Young's modulus: $E = E_c\left[1 + 8\left(E_s/E_c - 1\right)\left(r_s/D - 3r_s^{\ 2}/D^2 + 4r_s^{\ 3}/D^3 - 2r_s^{\ 3}/D^3\right)\right]$, where E_c and E_s denote elastic moduli for core and shell, r_s is shell thickness, and D is outer diameter can be used for cylindrical nanobeam (Chen et al. *Physical Review Letters* 96(7) 075505 (2006)). For $E_c = 60$ GPa, $E_s = 50$ GPa, $r_s = 2$ nm, the change of the composite modulus would be only 5% for nanowires with radii of 20-120 nm (Figure S2a, yellow line). For $E_c = 60$ GPa, $E_s = 368$ GPa, $r_s = 2$ nm, stiffening effect (increase by 70%) can be observed (Figure S2a, green line).

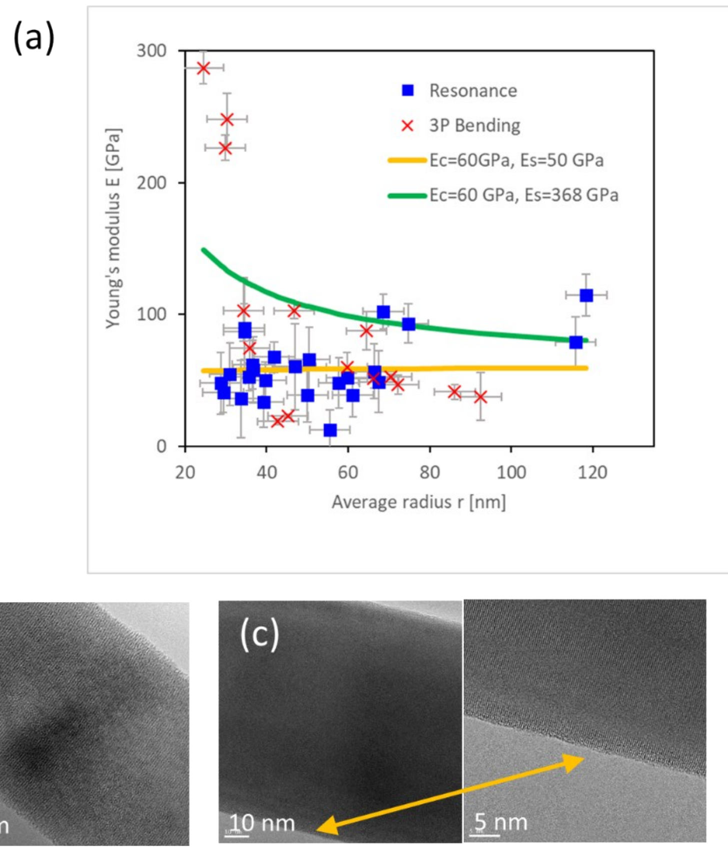

Figure S2 (a) Experimental data of the Young's moduli (blue squares for resonance, red crosses for 3P bending); effective Young's moduli calculated from core-shell model for $E_c = 60$ GPa, $E_s = 50$ GPa, $r_s = 2$ nm (yellow line), $E_c = 60$ GPa, $E_s = 368$ GPa, $r_s = 2$ nm (green line); (b) TEM image of nanowire with diameter 30 nm; (c) TEM image of nanowire with diameter 100 nm.

The oxide thicknesses were measured for several different sized GeSn nanowires. Transmission electron microscopy images (Figure S2b, c) provide example for two typical nanowires with diameters 30 nm and 100 nm, which showed amorphous layer of not exceeding 2 nm.