18p-F11-17

Enhancement of Thermoelectric Properties via Radial Dopant Distribution in Boron-doped Silicon Nanowires

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We demonstrate the enhancement of thermoelectric properties via radially inhomogeneous dopant distributions in B-doped Si nanowires. The spatial distribution of B dopants within Si nanowires was unintentionally inhomogeneous due to the occurrence of sidewall vapor-solid growth during the vapor-liquid-solid nanowire growth, resulting in the heavily doped outer shell layer. The thermopower measurements for the single nanowire demonstrated that the Seebeck coefficient value was enhanced up to 1.8 times compared with homogeneously B-doped Si when the resistivity was above 10^{-2} Ωcm. The field effect measurements clarified that the apparent hole mobility values of these nanowires were higher than those of homogeneously B-doped Si in such resistivity range. The presence of mobile carriers diffused from the heavily doped outer shell layer into the lightly doped inner core seems to play an important role on the deviation between the present inhomogeneous B-doped Si nanowires and the homogeneously doped system on the Seebeck coefficient data. [results from delta doped Silicon nanowire] These results highlight that intentionally tailoring inhomogeneous radial dopant distributions offers a new way to improve the thermoelectric properties of semiconductor nanowires.