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Modulation of Thermoelectric Power Factor via Radial Dopant Inhomogeneity in B-doped Si Nanowires

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We demonstrate a modulation of thermoelectric power factor via a radial dopant inhomogeneity in B-doped Si nanowires. These nanowires were naturally composed of a heavily doped outer shell layer and a lightly doped inner core due to the occurrence of vapor-solid growth on the nanowire surface during vapor-liquid-solid (VLS) method. The thermopower measurements for a single nanowire demonstrated that the power factor value increased up to 1.8 times compared with homogeneously B-doped Si when the apparent nanowire resistivity was above 10^{-2} Ωcm. The field effect measurements clarified that in such resistivity range the hole mobility values of these nanowires were higher than those of homogeneously B-doped Si. This mobility enhancement lowers overall electrical resistivity of nanowires while without decreasing Seebeck coefficient value, resulting in the modulation of thermoelectric power factor. In addition, we found that tailoring the surface dopant distribution by introducing surface δ-doping can further increase the power factor value. Thus, intentionally tailoring radial dopant inhomogeneity promises a way to improve the thermoelectric power factor of semiconductor nanowires.