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Electronic Transport Processes in Heavily Doped Uncompensated and Compensated Silicon as Probed by the Thermoelectric Power

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Abstract

The thermoelectric power S and electrical resistivity ρ, measured between 1.5 and 30 K, of just insulating, heavily doped Si show distinct differences between uncompensated and compensated samples. S(T) of Si:P exhibits a sign change from S<0 to S>0 with decreasing T at a temperature $T_{S=0}$ which increases sharply with decreasing carrier concentration N below $N_0=2.78\times10^{18}cm^{-3}$. Below N_0, ρ(T) shows activated conduction over an energy gap E_2 which has the same N dependence as $T_{S=0}$. This is attributed to the splitting of the two Hubbard bands. In contrast, S(T) of Si:(P, B) is negative in the whole N and T range investigated and ρ(T) shows Efros-Shklovskii variable-range hopping down to the lowest N.