THERMOELECTRIC PROPERTIES OF UO_2

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ABSTRACT

The Seebeck Coefficient for UO_2 at room temperature is more than three times greater than the current best thermoelectric material, doped BiTe alloys. This suggests that UO_2 can be used as a material for thermoelectric devices. Thermoelectric devices have a wide variety of applications in many fields. For example, solid state refrigerators are used to cool high power integrated circuits, superconducting devices, and infrared detectors, while thermoelectric power converters are utilized in waste heat energy applications and deep space probes. Substantial data—thermal conductivity, electrical resistivity, and even the Seebeck coefficient—have been gathered for UO_2 for nuclear reactor safety purposes. However, no data exists for dopants of uranium. Thus, it is concluded that UO_2 has never been seriously considered for uranium-based semiconductor applications such as thermoelectric devices. The performance of a thermoelectric material is quantified using the dimensionless figure-of-merit $ZT=S^2 \sigma T/k$, where S is Seebeck coefficient, σ is electrical conductivity, and k is thermal conductivity. A ZT of ~2–3, thermoelectric refrigerators could be competitive with today's vapor compression devices. Calculations give a ZT ~ 10^{-4} for UO_2 at 500 K, and, ZT ~ 0.1 at 2,273 K. The figure-of-merit increases with increasing temperature for UO_2.