Al-based quasicrystal as a thermoelectric material

Thermoelectric figure of merit

$$ZT = \frac{S^2 \sigma}{\kappa} T$$

Seebeck coefficient S

Metal: low, Semiconductor: high, Quasicrystal: medium

Electrical conductivity σ

Metal: high, Semiconductor: low, Quasicrystal: medium

Thermal conductivity κ

Crystalline: high, Amorphous: low, Quasicrystalline: low

Typical properties

Bi_2Te_3 (Conventional material)	$Al_{68}Ga_3Pd_{20}Mn_9$ Quasicrystal (the highest performance so far*)
S: ~200μV/K	S: ~90μV/K ×
σ: ~1000/Ωcm	σ: ~700/Ωcm △
κ: ~1W/mK	κ: ~1W/mK ◎
ZT: ~1	ZT: ~0.26 △
Cost: expensive(△Bi, △Te)	Cost: still expensive(◎Al, △Ga, △Pd, △Mn)
Band gap: ~0.2eV	Band gap: × (pseudo-gap)

Key point

✓Electrons and Holes may compensate each other in quasicrystals (like semimetal).

✓How to introduce a narrow band gap?

* Y. Takagiwa, T. Kamimura, S. Hosoi, J. T. Okada and K. Kimura, *J. Appl. Phys.* **104**, 073721 (2008).