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Correlated Evolution of Colossal Thermoelectric Effect and Kondo Insulating Behavior[1]

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$FeSb_2$ is a widely studied thermoelectric material with an unprecedentedly large low-temperature Seebeck coefficient whose origin is still being investigated. Its other electronic and magnetic properties show signatures of electronic correlations that suggest that the material is a Kondo insulator. A better understanding of the physics underlying the exceptional thermoelectric behavior is strongly needed. Even before a comprehensive understanding is attained, however, the principles already discovered are enough to warrant more attention in the search for advanced thermoelectrics. Towards this end, here we describe our work on how the Seebeck coefficient, electrical resistivity, and magnetic susceptibility of $FeSb_2$ evolve together as the material is chemically tuned through varying degrees of electronic correlation. This was done by forming alloys with the conventional semiconductor $RuSb_2$, whose more delocalized d orbitals provided the key tuning parameter. The systematic development of the properties resulting from this straightforward chemical change enable us to construct a phase diagram that demonstrates how the colossal thermoelectric performance of $FeSb_2$ emerges as the electronic correlation is increased and implies new principles for directing the continual search for advanced thermoelectric materials. This work is based on the Ph.D thesis of Michael K. Fuccillo, with collaborators Quinn D. Gibson, Mazhar N. Ali, and Leslie M. Schoop.

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