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# Pressure Tuning of a Platinum Kondo Insulator

The application of high pressures to a material can alter its internal interaction parameters, such as the magnetic and electronic effects, structures and densities, so that new solid state materials with useful properties may result. The high pressures affect the properties of a material, often giving it a completely new set of characteristics and behaviours. Pressure can be varied rapidly and be applied in particular directions, and thus be used to 'tune' the interaction parameters, and hence the properties. Thermoelectric materials are especially sensitive to pressure, so the use of pressure tuning techniques to study their thermoelectric properties and to search for new, improved semiconductor materials, is of interest.

One class of compounds known as Kondo insulators, which are semiconducting insulators with a narrow band gap energy, exhibiting intermediate valence properties, have some of the highest thermoelectric properties known. Scientists at Pennsylvania State University, Cornell University and the Carnegie Institution of Washington have now managed to pressure tune a neodymium-doped Kondo insulator, $Nd_xCe_{3-x}Pt_3Sb_4$, where $x$ = 0.27 or 0.45, so as to increase its thermoelectric properties significantly (J. F. Meng, D. A. Polvani, C. D. W. Jones, F. J. DiSalvo, Y. Fei and J. V. Badding, *Chem. Mater.*, 2000, **12**, (1), 197–201).

On placing $Nd_{0.45}Ce_{2.55}Pt_3Sb_4$ in an octahedral multi-anvil pressure cell, its thermopower was increased from 80 $\mu V K^{-1}$ near ambient pressure at 298 K to 100 $\mu V K^{-1}$ at 2 GPa. However, when it was compressed inside a nonhydrostatic diamond anvil cell, its electrical conductivity increased by a factor of 1.5–2 and its thermopower increased from 82 $\mu V K^{-1}$ at ambient pressure to a maximum of 263 $\mu V K^{-1}$ at 1.9 GPa. Upon further increase in pressure, the thermopower dropped and when the pressure was reduced hysteresis was seen, probably due to irreversible structural changes. No hysteresis occurs if pressure is only increased to produce the maximum thermoelectric power.

Pressure tuning can therefore act as an indicator of which materials, in this case thermoelectric materials, are worthy of chemical synthesis for further study at ambient pressures.

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