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Transparent Conducting Oxides as Potential Thermoelectrics[1]

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Transparent conducting oxides (TCOs) in their less-doped semiconducting states have potential as thermoelectric oxides or TEOs. They are attractive as TEOs owing to: 1) their good thermochemical stability, 2) their n-type character (to complement existing p-type TEOs), and 3) their high electronic mobilities. The numerator of the TE figure of merit (Z), also known as the "power factor" (PF), is the product of the electronic conductivity and the square of the Seebeck coefficient. An experimental procedure named after its developer, "Jonker" analysis plots Seebeck coefficient vs. the natural logarithm of the electronic conductivity. Data for bulk ceramic specimens just prior to the onset of degeneracy tend to fall on a line of slope, k/e (k=Boltzmann constant, e=charge of the electron). From this line, the doping composition corresponding to the highest power factor can be determined and the PF optimized, based upon data from a few carefully chosen compositions. Subsequently, following a procedure originally derived by Ioffe, the zero-thermopower intercept of these Jonker lines can be directly related to the maximum achievable power factor for a given TEO. So-called "Ioffe" plots allow for meaningful comparisons between candidate TEO materials, and also indicate the minimum thermal conductivity required to achieve a target ZT value at the temperature of measurement. Results for TCO-based TEOs will be discussed for both simple and compound (including layered) materials.

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