Polarization-based Perturbations to Thermopower and Electronic Conductivity in Highly Conductive Tungsten Bronze Structured (Sr,Ba)Nb_2O_6: Relaxors vs Normal Ferroelectrics

Author(s): J.A. Bock, S.Trolier-McKinstry, G.D. Mahan, and C.A. Randall

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Abstract: Electrical conductivity, thermopower, and lattice strain were investigated in the tetragonal tungsten bronze structured (Sr-x, Ba1-x) Nb_2O_6-delta system for $0.7 > x > 0.4$ with large values of delta. These materials show attractive thermoelectric characteristics, especially in single-crystal form. Here, the Sr/Ba ratio was changed in order to vary the material between a normal ferroelectric with long-range polarization to relaxor behavior with short-range order and dynamic polarization. The influence of this on the electrical conduction mechanisms was then investigated. The temperature dependence of both the thermopower and differential activation energy for conduction suggests that the electronic conduction is controlled by an impurity band with a mobility edge separating localized and delocalized states. Conduction is controlled via hopping at low temperatures, and as temperature rises electrons are activated above the mobility edge, resulting in a large increase in electrical conductivity. For relaxor ferroelectric-based compositions, when dynamic short-range order polarization is present in the system, trends in the differential activation energy and thermopower show deviations from this conduction mechanism. The results are consistent with the polarization acting as a source of disorder that affects the location of the mobility edge and, therefore, the activation energy for conduction.