A Polar Expedition in Oxides

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Polar oxides form a major cornerstone of the modern electronics industry, with two materials, in particular, dominating. These both adopt the perovskite crystal structure, ABO_3: $BaTiO_3$ is used as the dielectric in the *1000+ billion* ceramics capacitors we fabricate every year; and $Pb(Zr,Ti)O_3$ (PZT) is used in a diverse variety of piezoelectric actuators, transducers and sensors. Despite their widespread use, each material has a drawback: 1) the useful working temperature range for $BaTiO_3$ is limited by a modest Curie temperature of 130 oC; and 2) for PZT it is desirable to avoid the use of Pb-containing compounds (despite a current EU exemption which is exclusive to PZT). These challenges offer great opportunity for solid-state scientists and I will describe some of our recent work in trying to understand how to control the Curie temperature in $BaTiO_3$ by chemically-induced strain and also our attempts to develop a global understanding of composition-structure-property inter-relationships in polar materials with the tetragonal tungsten bronze structure, $A1_2A2_4B1_2B2_8C_4O_{30}$, which is closely related to perovskite.