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Large Force Ceramic Actuators for Smart Systems. Waltraud M. Kriven, Dept. of Materials Science and Engineering, Univ. of Illinois at Urbana-Champaign, Urbana, IL, USA.

The current knowledge of non-electroactive, phase transformations in ceramics is summarized in the context of crystallographic unit cell volume change or shape change, as well as transformation temperature and hysteresis. Applications of accompanying volume changes leading to structural ceramics via transformation toughening, or transformation weakening of debonding interphases, are demonstrated. Ferroelasticity and ferroelastic transformations at ~830°C have been studied in the lanthanide-type niobates ($YNbO_4$) which have the scheelite-type structure. The undergo a second order transformation from high temperature tetragonal to low temperature monoclinic symmetry. Large spontaneous strains strain of ~6.35% are calculated, as compared to 0.01% observed in conventional PZT actuators. In situ high temperature (>1700°C) studies have been made in air, using a quadrupole furnace developed in our laboratory, synchrotron radiation (APS, SNLS) and Rietveld analyses. It is interesting to note that the source of the spontaneous strain arises not only from thermal contraction during cooling to room temperature but also from the monoclinic unit cell shape changes of 90° at transformation (830°C) to 94.6° at room temperature. Potential applications of ferroelastic domain rearrangements coupled with the ferroelastic transformation resulting in "rubber-like behavior" are being investigated. Potential applications are as large force actuators in MEMS devices and as robotic shape memory ceramics.