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Structure-property relationships of functional perovskite-based ceramics

Ceramics are at the heart of modern electronic devices, in particular perovskite-based ceramics, because they exhibit a multitude of dielectric properties. In general, these ceramics are employed for charge storage, generation and sensing. These functions are based in phenomena such as ferroelectricity and piezoelectricity, which in the case of perovskites can be systematically modified due to the flexibility of this structure to accommodate almost every element of the periodic table. Basically, this flexibility allows a precise control of both the magnitude of the dielectric constant, the electrical conductivity and the magnetic characteristics. Hence, thanks to this remarkable variety of electrical properties, perovskites can be used as dielectrics in wireless communication systems, high dielectric constant capacitors, piezoelectrics for fuel injection systems, temperature sensors, etc...

Structure-property relationships of doped CaTiO_3 and BaTiO_3 ceramics established by a combination of XRD, electron diffraction, Raman spectroscopy and electrical measurements will be presented. In particular, the crystallographic principles that control the permittivity and the temperature coefficient of resonant frequency in $\text{CaTiO}_3\text{-YAlO}_3$ ceramics, the stabilization of hexagonal BaTiO_3 by Ga doping and the effect of nanolevel phase separation on the dielectric properties of $\text{BaTiO}_3\text{-La(RE)O}_3$ (where $\text{RE}=\text{Y, Yb}$) ceramics. Finally, the extrinsic origins of large permittivity in CeAlO_3 and $(\text{La}_{0.4}\text{Ba}_{0.4}\text{Ca}_{0.2})(\text{Mn}_{0.4}\text{Ti}_{0.6})\text{O}_3$ ceramics will be discussed. These examples show how perovskites may offer permittivity values ranging from 20 to 20000, which can be tailored to vary with temperature only by a few ppm/K.