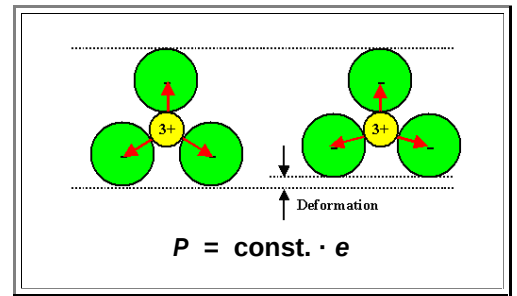


3.6.3 Summary to: Special Dielectrics

Polarization $\underline{P}$ of a dielectric material can also be induced by mechanical deformation $\underline{e}$ or by other means.

- **Piezo electric materials** are anisotropic crystals meeting certain symmetry conditions like crystalline quartz (SiO_2): the effect is linear.
- The effect also works in reverse: Electrical fields induce mechanical deformation
- Piezo electric materials have many uses, most prominent are quartz oscillators and, recently, fuel injectors for Diesel engines.



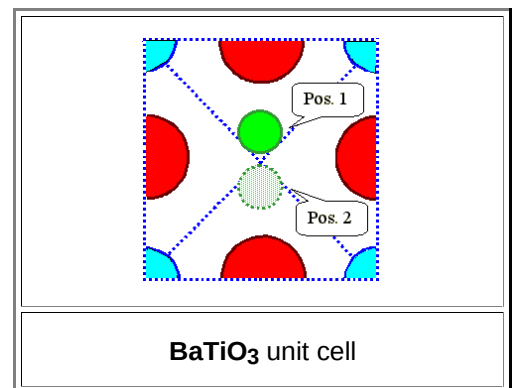
Electrostriction also couples polarization and mechanical deformation, but in a quadratic way and only in the direction "electrical fields induce (very small) deformations".

- The effect has little uses so far; it can be used to control very small movements, e.g. for manipulations in the **nm** region. Since it is coupled to electronic polarization, many materials show this effect.

$$e = \frac{\Delta l}{l} = \text{const} \cdot E^2$$

Ferro electric materials possess a permanent dipole moment in any elementary cell that, moreover, are all aligned (below a critical temperature).

- There are strong parallels to ferromagnetic materials (hence the strange name).
- Ferroelectric materials have large or even very large ($\epsilon_r > 1.000$) dielectric constants and thus are to be found inside capacitors with high capacities (but not-so-good high frequency performance)



Pyro electricity couples polarization to temperature changes; **electrets** are materials with permanent polarization, There are more "curiosities" along these lines, some of which have been made useful recently, or might be made useful - as material science and engineering progresses.

Questionnaire

Multiple Choice questions to all of 3.6