6.8: Piezoelectricity

Piezoelectricity is the property presented by certain materials that exhibit an electric polarization when submitted to an applied mechanical stress such as a uniaxial compression. Conversely, their shape changes when they are submitted to an external electric field; this is the converse piezoelectric effect. The piezoelectric effect and the converse effect are described by third-rank tensors:

- For a small stress, represented by a second-rank tensor, T_{ij}, the resulting polarization, of components P_k , is given by:

$P_k = d_{kij}T_{ij}$

where d_{kij} is a third-rank tensor representing the direct piezoelectric effect.

- For a small applied electric field, of components E_k, the resulting strain, represented by a second-rank tensor, S_{ij}, is given by:

$S_{ij} = d_{ijk}E_k + Q_{ijkl}E_kE_l$

where the first-order term, d_{ijk}, represents the inverse piezoelectric effect and the second-order term, Q_{ijkl}, a symmetric fourth-rank tensor, the electrostriction effect. The sense of the strain due to the piezoelectric effect changes when the sign of the applied electric field changes , while that due to electrostriction, a quadratic effect, does not.

The matrices associated to the coefficients d_{kij} and d_{kij} of the direct and converse piezoelectric effects, respectively, are transpose of one another.