HIGH-RANK ELECTRIC POLAR MOMENTS AND PIEZOELECTRICITY

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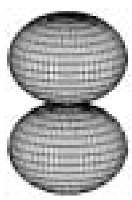
It occurs a fundamental affinity between piezoelectricity and pyroelectricity: both phenomena are the result of multipole electrical moment M_{ijk} inherent in polar crystal. However, a substantial distinction exist between their polar properties. In fact, non-central crystal internal polarity is compensated entirely for the "actual" piezoelectric, and this looks similarly to the electric charge neutrality principle. It is predicated that completely compensated multipole moment is a distinctive feature of "true" piezoelectric, and, in the undisturbed crystal, as well as for any *scalar* impact on it, no electrical evidence of M_{ijk} can be obtained (nevertheless, such an evidence will be first recovered in this report).

Pyroelectric (or ferroelectric) has an additional, uncompensated part of M_{ijk} that looks like a vectorial moment $M_i = P_S$, in other words, this is a spontaneous polarization. The P_S testimony is got experimentally from the pyroelectric effect, using a *scalar* temperature action on crystal. Electrical evidence of P_S might be obtained also by other scalar disturbance, thus, isotropic pressure produces volumetric piezoeffect (that is considered impossible in the "actual" piezoelectric). Spatial distribution of P_S in pyroelectric is shown on Fig.*a*.

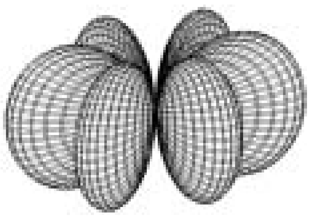
As regards to the multipole M_{ij}, a second rank latent moment is 2-D = sextupole (Fig.*b*) which is typical for quartz crystal. The third rank polar moment M_{ijk} is familiar for III-V type semiconductor, and it corresponds to 3-D = octupole that is shown on Fig.*c*. It was presumed that the only a *non-isotropic* influence (such as directed mechanical stress) can produce in these crystals electric response (piezoelectric effect). Yet another opportunity is uncovered below.

A novel result is obtained in our experiments, studying the *partially clamped* "actual" piezoelectrics. We succeeded in the de-compensation of internal polarity, and have got the temperature dependence for an amplitude components (modulus $|\mathbf{M}|$) of the appropriate multipole. Experiments were made for well-known piezoelectric crystals (α-quartz, GaAs, KDP above Curie point, etc.). It is shown that M_{ijk}-modulus in the examined piezoelectrics decreases with temperature like in the ferroelectrics, because it vanishes at quite definite phase transition temperature "θ" by a critical law $(\theta - T)^n$, Fig. *d*. It is established that the exponent $n = 2$ if the multipole is a 3-D octupole, and $n = 1$ in the case of M_{ij} represents 2-D sextupole; unlike Landau critical index $n \approx 0.5$ specific for the 1-D moment $M_i = Ps$ – spontaneous polarization.

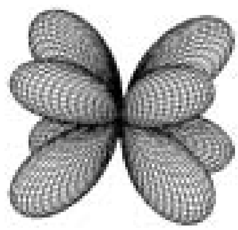
(a)



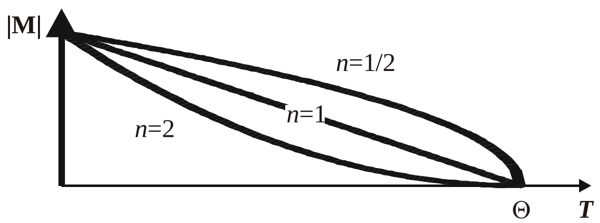
(b)



(c)



(d)



Besides being electronic devices, all of these applications utilize piezoelectricity in some way. Letâ€™s explore how piezoelectricity works and look at some applications of piezoelectric materials in day to day life. How Does Piezoelectric Material Work? Dating all the way back to 1880 and the groundbreaking work of brothers Pierre and Jacques Curie, the piezoelectric effect refers to the ability of specific materials â€" such as quartz, tourmaline, topaz and Rochelle salt â€" to produce an electric charge when subjected to mechanical stress. The term â€œpiezoâ€ can even trace its roots back to ancien The electric dipole moment p of two charges + q and âˆ' q separated by a distance l is a vector of magnitude p = q l with a direction from the negative to the positive charge. An electric dipole in an external electric field is subjected to a torque Ï„ = p E sin Î¸, where Î¸ is the angle between p and E . The torque tends to align the dipole moment p in the direction of E . The potential energy of the dipole is given by U e = âˆ' p E cos Î¸, or in vector notation U e = âˆ' p Â·. E . In a nonuniform electric field, the potential energy of an electric dipole also varies with position, and the dipole can be...Â The polarization of a medium P gives the electric dipole moment per unit volume of the material; it is expressed in units of coulombs per metre squared. Piezoelectric energy harvesting (PEH) has been a salient topic in the literature and has attracted widespread attention from researchers due to its advantages of simple architecture, high power density, and good scal-ability. This paper presents a comprehensive review on the state-of-the-art of piezoelectric energy harvesting. Various key aspects to improve the overall performance of a PEH device are discussed, including basic fundamentals and congurations, materials and fabrication, performance enhance-ment mechanisms, applications, and future outlooks. Published by AIP Publishing. https://do However, piezoelectric material exhibits an electric behavior and acts as a dipole only below a certain temperature called Curie temperature. Above the Curie point, the crystalline structure will have a simple cubic symmetry so no dipole moment (see first sketch of Figure 1). On the contrary, below the Curie point, the crystal will have a tetragonal or rhombihedral symmetry hence a dipole moment (see second sketch of Figure 1). As explained earlier in this report, adjoining dipoles form regions called Weiss domains and. exhibit a larger dipole moment as every dipole in the domain has roughly t...Â A piezoelectric material develops an internal electric field when strained.Â then converting the solutions to polar solutions : with : u -kHie'. Piezoelectricity (literally, "pressing electricity") is much simpler than it sounds: it just means using crystals to convert mechanical energy into electricity or vice-versa.Â Now the effects of the charges (their dipole moments) no longer cancel one another out and net positive and negative charges appear on opposite crystal faces. By squeezing the crystal, you've produced a voltage across its opposite facesâ€"and that's piezoelectricity! What is piezoelectricity used for? Photo: A typical piezoelectric transducer.