

2.2 Temperature Dependence and Dispersion of Electro-optic and Elasto-optic Response in Perovskite Crystals

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It is unanimously recognised that perovskites belong to a material class of fundamental importance for electro-optic, nonlinear-optic as well as acousto-optic applications. The electro- and the elasto-optic responses have already been measured in many materials at different frequencies of the applied electric field. On the other hand, very few experiments have been devoted to the investigation of the temperature dependence and the light wavelength dispersion of these effects. After we had determined a complete set of parameters to relate the dielectric, elastic, piezoelectric, electro-optic and elasto-optic properties of BaTiO₃ and KNbO₃ at room temperature, we turned our attention to the temperature dependence and the optical wavelength dispersion.

Our work started with a review of a theory of the 70's based on the microscopic explanation of the electro-optic and nonlinear-optic effects in these ferroelectrics in terms of the quadratic polarisation-optic effect biased by the spontaneous polarisation. According to this interpretation, the linear electro-optic properties are considered as a second order effects induced by the appearance of the spontaneous polarisation. This model predicts that the linear electro-optic coefficients can be expressed by combinations of the quadratic polarisation-optic tensor of the nonpolar cubic phase, the dielectric permittivity and the spontaneous polarisation. With these three quantities only, we are now able to predict the linear electro-optic and elasto-optic properties of the perovskite materials at all temperatures, in all the ferroelectric phases and at all optical wavelengths. Numerical evaluation of all these coefficients of the room temperature polar phases for two typical perovskite crystals BaTiO₃ and KNbO₃ were done. Modifications of the electro-optic properties in doped crystals, mainly due to a change of the dielectric permittivity, were also discussed in the frame of the same model.