# Electrooptic and Photorefractive Effects at the Paraelectric Phase: Phenomena, Applications, and Device Construction

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Potassium tantalate niobate (KTN) is an oxygen perovskite crystal which at the paraelectric (PE) phase exhibits an exceptionally strong quadratic electrooptical (EO) effect. At temperatures slightly above the ferroelectric (FE) phase transition temperature $T_c$, KTN manifests an electrically induced change in the refractive index of $\approx 10^{-2}$. And yet, this exceptionally strong EO effect has hardly been exploited for applications.

This is partly because of scattering that occur in the vicinity of $T_c$. Investigations of these scattering phenomena reveal that the EO effect in this region is governed by the interplay between the classical deterministic "crystal optics" mechanism, and the stochastic formation of dipolar clusters that occur in the vicinity of Tc, fluctuating in space and time.

It will be shown how these scattering phenomena affect the EO behavior of KTN, and how they can be inhibited in potassium lithium tantalate niobate (KLTN). It will also be shown how KLTN can be operated at visible wavelengths without developing optical damage due to the formation of random space charge.

The photorefractive (PR) effect at the paraelectric phase in the vicinity of Tc will then be discussed, and its use for electroholography will be shown. Electroholographic diffraction with wide range electric tunability of the Bragg condition will be demonstrated. Emloying this phenomenon for the implementation of a laser with electric tunability through the entire C band.

The effect of the dipolar clusters on beam propagation in photorefractive KLTN will then be discussed, in particular, diffractionless propagation in minute reduced refractive index tunnels formed by fast quenching of the dipolar clusters to freeze spatial solitons.

Finally, a generic fabrication technique of 3D structures with sub-wavelength dimensions and reduced refractive index based on the implementation of fast ions in a KLTN substrate will be presented, and its potential for the construction of complex EO integrated circuits in which multitudes of EO devices and photonic structures are interconnected by a mesh of waveguides and operate in unison.

 