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Phase matching by electro-optic effect in DKDP crystal for high power laser

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The relation of optical characters and deuteration fraction in the deuterated KDP (DKDP) crystal is studied. The most important related-parameter, that is the refractive index of DKDP crystal, is theoretically and experimentally derived. At first, the refractive indices of both pure KDP and DKDP crystals for ordinary and extraordinary rays are measured. Second, temperature and wavelength dependence on deuteration fraction are simulated theoretically. Finally, the gain spectra and frequency conversion efficiency are deduced in the case of second and third harmonic generation (SHG and THG) at various power densities. We report a new class of methods aimed at achieving quasi perfect phase matching, based on controllable birefringence produced via the linear electro-optic effect, termed "voltage turning phase matching". The wave vectors of the induced polarization and the generated fields can be matched and maintained along the direction of propagation by introducing an external electric field. We analyze the validity and feasibility of this method theoretically and demonstrate it experimentally by applying the linear electro-optic effect and fourth-harmonic generation simultaneously in DKDP crystal. Quasi perfect phase matching is achieved systematically over a temperature range of the initial phase-matching temperature -2°C. Moreover, this method can overcome the limitation of the birefringence in traditional technologies and provides new functionalities for conventional nonlinear materials as well as low birefringence and isotropic materials. This technology may significantly impact the study of optical frequency conversion and has promise for a broad range of applications in nonlinear optics.

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