ADVANCES IN FREQUENCY CONVERTERS WITH STRUCTURED FERROELECTRICS

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This year, 2011, marks the 50-th anniversary of the first experimental demonstration of frequency conversion employing second harmonic generation in crystal quartz [1]. Only one year later, in 1962, the seminal paper by J Armstrong and co-workers [2] proposed the principle of quasi phase-matching (QPM) as a generic method to increase the efficiency of second order interactions in different classes of materials. However only since the mid-1990's the QPM frequency conversion started to make serious inroads into the field of nonlinear optics and applications. Substantial effort over the last 10 years has been devoted to tailor the properties of the most popular oxide ferroelectrics used for QPM structure fabrication, $KTiOPO_4$ (KTP), $LiNbO_3$ (LN) and $LiTaO_3$ (LT). The flexibility of engineered nonlinear interactions by appropriately designing QPM structure proved to be very enticing for many applications of nonlinear optics. Some of these capabilities unique for QPM nonlinear media will be reviewed in this talk.

Mirrorless optical parametric oscillator [3] exploiting counter-propagating nonlinear interaction in QPM crystals structured with sub-micrometer periodicity [4], and 2D nonlinear photonic crystals where optical parametric generation of two coherently coupled processes occurs [5], are good examples of the unique capabilities of the QPM technique. Advances in structuring techniques of nonlinear ferroelectrics allow design of the transversal phase distribution of the waves generated in the nonlinear interaction leading to some interesting properties of the output beams [6]. The QPM technique allows realizing of the noncritical nonlinear interactions over the whole transparency range of the ferroelectric crystals, particularly in $KTiOPO_4$, where small-period structuring is well established. However, up to recently it was assumed that the QPM frequency converters are suitable only for low energy applications. Recent developments in nonlinear ferroelectric materials now allows fabrication of large optical aperture crystals suitable for generation of nanosecond pulses with energies substantially exceeding 100 mJ in mid-infrared spectral range [7].

References:

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