Development of Organic Ferroelectrics Using Low-Molecular-Weight Materials

Ferroelectrics are important industrial materials which are widely used for electronic applications such as nonvolatile memories, piezoelectric elements, actuators, insulating films for field effect transistors. Material design and synthesis of low-molecular-weight organic ferroelectrics, though unexplored field in comparison with inorganic or polymer ferroelectrics, have been desired to realize these excellent functions flexibly in lightweight materials. Recently, we have achieved completely new approach to ferroelectricity using molecular compound, in which 2 species of π-electron molecules are bounded by hydrogen bonds. The present ferroelectrics possess outstanding properties; spontaneous polarization which can be reversed in a low field approximately 1/100 of that required for polymers and huge permittivity reaching as much as 2,000-3,000.

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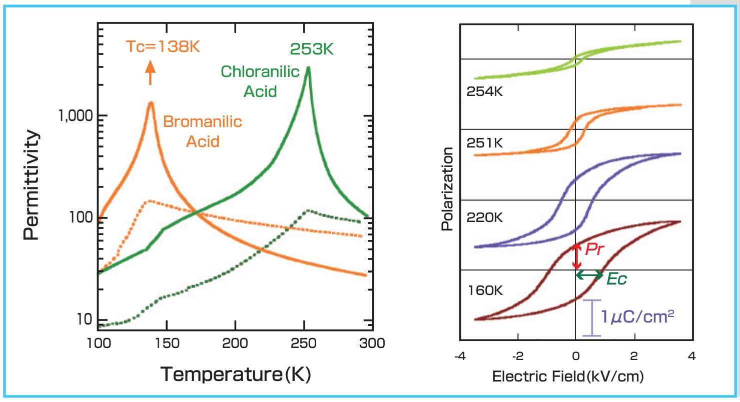

Figure: 〔Lef〕 Permittivity of crystals of phenazine-chloranilic acid and phenazine-bromanilic acid. (Solid and broken lines represent data with electric field applied parallel to and perpendicular to the polar axis.) 〔Right〕 Polarization-electric field hysteresis curves of the phenazine-chloranilic acid crystal.

Toward the realization of ultimate continuous-wave light sources

Generation of arbitrary wavelength light with a continuous-wave optical parametric oscillator

We are developing a continuous-wave (cw) optical parametric oscillator as a tunable cw light source used in an optical frequency synthesizer. The tuning range from 777 nm to 1687 nm was obtained with a 5% MgO doped $LiNbO_3$ as a nonlinear crystal. The Doppler broadened fluorescence profile of the Cs-D_2 line (852.357 nm) was observed and we could demonstrate the tunability to arbitrary wavelength. The next target is the high-resolution spectroscopy of atoms and molecules with a cw-OPO phase-locked to an optical comb.

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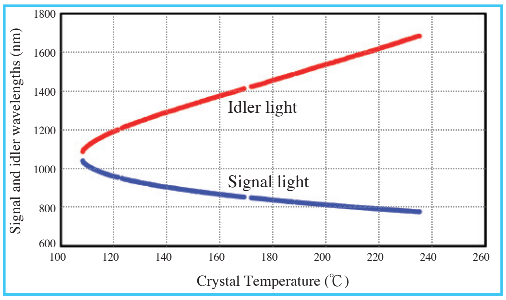

Fig 1: Temperature tuning curve of the continuous-wave optical parametric oscillator

By tuning the crystal temperature from 108°C to 235°C, the cw-OPO generated the wavelengths from 777nm to 1687nm, which is more than 1 octave. The signal light and the idler light at same temperature point oscillate simultameously.

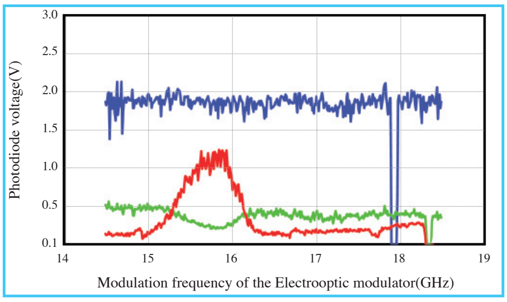

Fig 2: Observed Doppler-broadened signal from the Cs-D2 line (852nm) The transition from a ground state hyperfine level F=4 to excited states F'=3,4,5 was obssrved. An electrooptic modulator was used for continuous frequency tuning. Blue line: signal light intensity, Green line: light intensity transmitted through the cell, Red line: fluorescence intensity from the cell. The light was blocked at 17.9 GHz and 18.3 GHz for the zero-level calibration of photodetectors.