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4-dimethylamino-N-methyl-4-stilbazolium tosylate (DAST) is a well-known organic nonlinear optical material for emitting high-power and broadband terahertz (THz) wave. However, it had nearly reported about the crystals of DAST-derivative materials and their properties as a THz wave source. In this study, we designed new DAST-derivative materials, grew these crystals, and investigated their THz-wave properties. We synthesized various DAST-derivative materials such as 1-methyl-4-{2-[4-hydroxyphenyl]ethenyl} pridinium p-toluenesulfonate (MC-pTS), new material named bis[1-methyl-4-{2-[4-(dimethylamino)phenyl]ethenyl}pridinium] terephthanate (BDAS-TP), and so on. Then we prepared their solutions with methanol solvent, and grew their crystals by using slow-cooling process. Fig. 1 shows the obtained crystals of MC-pTS and BDAS-TP. By using a femtosecond laser, we found BDAS-TP crystal can generate broadband THz-wave.

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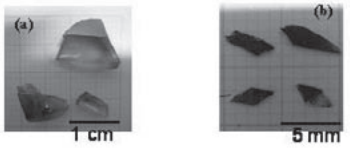

Fig.1 Crystals of DAST derivatives (a) MC-*p*TS (b) BDAS-TP

Keywords: laser and nonlinear optical materials, organic chemistry, crystal growth from solution

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Neutron and X-ray powder diffraction investigation of $LaMnO_3$

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The parent compound $LaMnO_3$ of the hole-doped colossal magneto-resistance (CMR) materials crystallizes in the orthorhombic space group Pbnm. The structure consists of MnO_6 octahedra that are distorted due to the Jahn-Teller effects. Below TO = 750 K $LaMnO_3$ has an orbital ordered state that consists of the Mn^{3+} eg orbitals in an alternate staggered pattern in the a-b plane that repeats itself along the c axis. This type of orbital order induces A-type antiferromagnetic (AF) ordering below TN = 141 K and coexists with it. In the A-type AF phase the ferromagnetic a-b plane are stacked antiferromagnetically along the c-axis. We have investigated the orbital order-disorder transition in $LaMnO_3$ by high temperature X-ray powder diffraction with synchrotron radiation and also neutron powder diffraction. The unit cell volume of $LaMnO_3$ increases with increasing temperature and at higher temperature it starts decreasing in a narrow temperature range below TO = 750 K, and then undergoes a volume collapse at TO. The Pbnm symmetry of $LaMnO_3$ is retained above TO although the unit cell becomes pseudo-cubic. We have constructed a theory of this phase transition by a model Hamiltonian involving the pseudo-spin of Mn^{3+} eg states, the staggered JT distortion and the volume strain coordinate. We also investigated the magnetoelastic effect at the antiferromagnetic phase transition in $LaMnO_3$ by neutron powder diffraction. The lattice parameters a decreases with temperature up to TN = 141 K and then abruptly starts increasing whereas the lattice b shows the opposite effect. The third lattice parameter c and the unit cell volume show only weak anomalies close to TN. We interpreted these results in terms of a spin-lattice coupling Hamiltonian and have extracted the coupling constant.

Keywords: orbital ordering, antiferromagnetic ordering, magneto-elastic effect

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Tuning magnetic interaction in orthorhombic neodymium-yttrium manganites $Nd_{1-x}Y_xMnO_3$

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By lowering the Mn-O-Mn bond angle in $LnMnO_3$ with Ln=La-Ho the Neel-temperature decreases and at Ln=Tb the A-type antiferromagnet transforms to an incommensurate (IC) spin-spiral phase for Ln=Gd,Tb,Dy. The spin-spiral breaks both inversion and time reversal symmetry leading to a strong coupling between magnetism and ferroelectric polarization. We investigate the evolution of the crystal and magnetic structure from the A-type phase to the IC spin spiral phase by systematically replacing neodymium by yttrium in $NdMnO_3$ resulting to a decrease of the tolerance factors to values similar to that for multiferroic $TbMnO_3$. One advantage of this approach is that the tolerance factor can be tuned and that neodymium and yttrium are not high neutron absorbing elements in sharp contrast to other rare earths like Gd, Dy and Eu. Compositions x=0.0 to 0.6 have been prepared, neutron and x-ray powder diffraction patterns were measured as well as the magnetic properties. It can be shown that by decreasing the tolerance factor that way, similar effects can be seen as with varying the ionic size of the rare earth ions. For example we found that between $0.4<x<0.6$ the incommensurate phase co-exists with the A-type antiferromagnetic phase and with x=0.6 and higher the system is only incommensurate and seemingly multiferroic.

Keywords: manganites, muliferroics, $NdYMnO_3$

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Superstructures in $RBaCo_2O_{5.5}$ (R=Nd, Tb) as seen from reciprocal space mapping

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In $RBaCo_2O_{5.5}$ (R= rare earth element) the Co^{3+} ions can be found in either low spin state, an intermediate spin state or in a high spin state Providing that the energy difference between these states is small, i.e. ~k_BT, different electronic and vibrational degeneracy may lead, via an entropy factor, to a temperature induced spin-