

## 10-Physical and Chemical Properties of Materials in Relation to Structure (Superconductors, Fullerenes, etc)

307

The perovskite-like compound  $\text{LaVO}_3$  undergoes a crystallographic-antiferromagnetic transition at about 140 K. Recently, it has been shown that under a magnetic field of a few hundreds Oe the crystallographic transformation occurring in  $\text{LaVO}_3$  is accompanied by a magnetic transition into a large diamagnetic state below 135 K. In order to gain insight into the nature of this anomalous behavior, we have determined the structure of  $\text{LaVO}_3$  at room temperature and just above (150 K) and below (100 K) the transition. Synchrotron x-ray and neutron powder diffraction techniques were used. The lattice parameter variation vs. temperature and the structural refinements revealed that, above the transition, the structure of  $\text{LaVO}_3$  is of  $\text{GdFeO}_3$  type, namely it is orthorhombic with lattice parameters at room temperature:  $a = 5.55548(4)$ ,  $b = 7.84868(6)$ , and  $c = 5.55349(5)$  Å and space group  $Fm\bar{m}a$ . The orthorhombic distortion of the structure is very similar to that of isostructural  $\text{LaFeO}_3$ . At 100 K, below the transformation temperature, the structure is monoclinic with lattice parameters:  $a = 5.59360(4)$ ,  $b = 7.75951(5)$ ,  $c = 5.56490(3)$  Å,  $\gamma = 90.1251(4)^\circ$  and space group  $P2_1/a$ . In the orthorhombic structure all V sites are equivalent, but two independent sites, V1 and V2, are observed in the monoclinic structure. These two sites form alternate layers along the b axis. Above the transition all the V octahedra are tilted around the three crystallographic axes and are elongated along the [110] direction. The elongation increases at the transition and occurs in different directions,  $90^\circ$  apart, in the V1 and V2 octahedra. The low temperature magnetic structure and the results of field-cooling synchrotron x-ray and neutron powder diffraction experiments will be presented at the conference.

**PS-10.03.09 TWO STRUCTURAL FORMS OF DI(DIMETHYL)TETRASELENAFULVALENIUM) TETRAFLUOROBORATE.** By N. Thorup\*, Chemistry Department B, The Technical University of Denmark, Lyngby, Denmark, I. Johansen, NKT Research Center, Brøndby, Denmark, K. Bechgaard, CSMI, University of Copenhagen, Denmark, M.A. Beno, U. Geiser and J.M. Williams, Argonne National Laboratory, Illinois, USA.

The unsymmetrical organic donor 2,3-dimethyl-1,4,5,8-tetraselenafulvalene forms cation radical salts with inorganic anions. The 2:1 salt with tetrafluoroborate can be prepared by electrocrystallization, and two crystalline phases have been found. One form is tetragonal, space group  $I4_2d$ ,  $a = 18.336$  Å,  $c = 7.226$  Å. The structure contains stacks of cations along the c axis. Within a stack the cations are shifted along the long molecular axis in a zig-zag manner. The electrical conductivity is metallic at room temperature but at about 80 K a transition into semiconducting behavior is observed. A Peierls type transition is a likely explanation and a structure determination below this temperature has been attempted. The other crystal form is triclinic,  $P\bar{1}$ ,  $a = 7.284$ ,  $b = 12.810$ ,  $c = 13.826$  Å,  $\alpha = 83.44$ ,  $\beta = 80.16$ ,  $\gamma = 73.96^\circ$ . This structure contains two independent cations which are rotated approximately  $90^\circ$  with respect to each other and no pronounced stacking is present. These crystals are semiconducting in the temperature range studied. Polymorphism has been observed for many organic conductors (including superconductors) and as expected the physical properties are strongly related to the packing of the constituents in the crystal structure.

**PS-10.03.10 EUROPIUM (III) MOSSBAUER SPECTRUM AS PROBE OF MAGNESIUM (II) SITES IN LITHIUM NIOBATE CRYSTAL\*\*.** By Hongxi Zhang\*, Liangsheng Qiang and Chongquan Xu, Department of Applied Chemistry, Harbin Institute of Technology, Harbin 150006, P. R. China.

Because of the advantages of magnesium (II) doped lithium niobate ( $\text{Mg:LiNbO}_3$ ) crystal as electro-optic material, the local sites of  $\text{Mg}^{2+}$  in  $\text{LiNbO}_3$  have been widely investigated by various methods (D. A. Bryan et al., *Opt. Eng.*, 1985, 24, 138 and L. Arizmendi et al., *Phys. Rev.*, 1985, B31, 7138) and several models were proposed (Zhang Qiren et al., *Phys. Rev.*, 1991, B43, 12022, Zhou Yiyang et al., *Phys. Rev.* 1991, B43, 11374 and Zhang Hongxi et al., *J. Chinese Ceramic Soc.*, 1991, 19, 523). But no direct evidence can be used to confirm the position of  $\text{Mg}^{2+}$ . In the present paper, we report the Mössbauer spectra of  $\text{Eu}^{3+}$  in  $\text{Eu:LiNbO}_3$  and  $\text{Eu:Mg:LiNbO}_3$  crystals. Based on the Mössbauer parameter changes, the local site of  $\text{Mg}^{2+}$  is discussed.

Mössbauer absorbers were prepared from Czochralski-grown  $\text{Eu:LiNbO}_3$  (2.5mol%  $\text{Eu}_2\text{O}_3$ ) and  $\text{Eu:Mg:LiNbO}_3$  (2.5mol%  $\text{Eu}_2\text{O}_3$ , 6.0mol%  $\text{MgO}$ ) and  $\text{Eu}^{3+}$  density was about 20mg/cm<sup>3</sup>. Mössbauer spectra were recorded at room temperature on an OXFORD MS-500 constant acceleration Mössbauer spectrometer with a 1024 multi-channel analyzer. The radiation source was solid state  $\text{SmF}_3(^{152}\text{Sm})$ , about 100 mCi ( $^{152}\text{Eu}$ ). A xenon proportional counter was used as detector.  $\text{Eu}_2\text{O}_3$  as standard absorber.

Based on L. Arizmendi's spectroscopic measurement, we fitted the spectra with two Lorentzian lines and obtained the isomer shifts (IS) of  $\text{Eu}^{3+}$  in  $\text{Eu:LiNbO}_3$  and  $\text{Eu:Mg:LiNbO}_3$ . The result is listed in the following table and it indicates that  $\text{Eu}^{3+}$  can occupy both  $\text{Li}^+$  site ( $\text{Eu(Li)}$ ) and  $\text{Nb}^{5+}$  site ( $\text{Eu(Nb)}$ ).

Table Isomer shifts of  $\text{Eu}^{3+}$  in  $\text{Eu:LiNbO}_3$  and  $\text{Eu:Mg:LiNbO}_3$ .

Sample	IS	Line 1	Line 2
$\text{Eu:LiNbO}_3$	0.3675, $\text{Eu(Nb)}$ , 56%	-0.6182, $\text{Eu(Li)}$ , 44%	
$\text{Eu:Mg:LiNbO}_3$	0.2745, $\text{Eu(Nb)}$ , 48%	-0.9143, $\text{Eu(Li)}$ , 52%	

IS is very sensitive to  $\text{Eu-O}$  distance and increases with decreasing  $\text{Eu-O}$  distance (B. H. Oconnor et al., *Acta Cryst.*, 1969, B25, 2140). In  $\text{LiNbO}_3$ , average  $\text{Nb-O}$  distance is shorter than average  $\text{Li-O}$  distance (S. C. Abrahams et al., *Acta Cryst.*, 1986, B42, 61) and XRD analysis showed that  $\text{Eu}_2\text{O}_3$  doping does not cause structure changes. When  $\text{Eu}^{3+}$  replaces  $\text{Nb}^{5+}$  and  $\text{Li}^+$ ,  $\text{Eu(Nb)-O}$  distance is shorter than  $\text{Eu(Li)-O}$ . Therefore, it is deduced that, for  $\text{Eu:LiNbO}_3$  or  $\text{Eu:Mg:LiNbO}_3$ , the lower IS corresponds  $\text{Eu(Li)}$  and the higher IS to  $\text{Eu(Nb)}$ . From the relative integrated intensities of the two subspectra, we can estimate that about 56% (48%)  $\text{Eu}^{3+}$  occupy  $\text{Nb}^{5+}$  sites, 44%(52%)  $\text{Eu}^{3+}$  occupy  $\text{Li}^+$  sites in  $\text{Eu:LiNbO}_3$ ( $\text{Eu:Mg:LiNbO}_3$ ) respectively, also listed in the table. The results indicate that  $\text{Eu}^{3+}$  and  $\text{Mg}^{2+}$  compete in  $\text{Nb}^{5+}$  sites and the doping of  $\text{Mg}^{2+}$  into  $\text{Eu:LiNbO}_3$  decreases the ratio of  $\text{Eu(Nb)}$ . That means  $\text{Mg}^{2+}$  is preferred to occupy  $\text{Nb}^{5+}$  site. From the conclusion, we also analyse the mechanism of the increased anti-photorefractivity of  $\text{Mg:LiNbO}_3$ .

\*\* This project is supported by National Science Foundation of China.