Photoelectron spectroscopy of doped lead germanate - $Pb_5Ge_3O_{11}$

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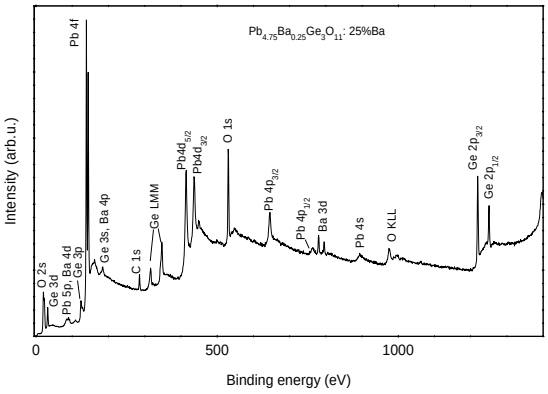
Lead germanate - $Pb_5Ge_3O_{11}$ is the ferroelectric crystal, which attracts attention due to its applicability in electro-optical devices related to its pyroelectric and photorefractive effects [1-3]. The influence of dopant elements: Ba, Ca, Sr, Cu, Mn, Nd on the electro-optical properties of lead germanate properties was investigated. The doping affects *e.g.* the pyroelectric coefficient, the spontaneous polarisation and causes the distinct shift in the para-ferroelectric phase transition temperature. Lead germanate exhibits second order phase transition at ≈ 450 K from the paraelectric phase with hexagonal space group P6 to the ferroelectric phase with a trigonal group P3. The structure of was determined to consist of two layers arranged alternately along c-axis within the Pb frame, that is layer of GeO_4 tetrahedra and a layer of Ge_2O_7 double tetrahedra. The properties of lead germanate shows a marked anisotropy due to the uniaxial structure, *e.g.* dielectric permittivity, piezoelectric and electrostrictive constants, refractive index, electro-optic coefficients and elastic constants. Dielectric permittivity of $Pb_5Ge_3O_{11}$ shows the anomaly characteristic for the second order transition. The electric conduction of the undoped lead germanate crystals is thermally activated, with activation energy E_a varying from 0.64 to 0.83 eV. The conduction mechanism is related to hopping movement of electrons, localised on point defects. In the case of Ba dopant, the transition temperature lowers almost linearly with a rate $\Delta T_C \approx 17.5$ K/mol %. The doping diffuses the dielectric constant peak near the phase transition and diminishes its maximum value. The barium ions influence electric conduction, lowering the activation energy to 0.35-0.51 eV, dependably on the concentration. Moreover, the Ba- doping enhances the pyroelectric coefficient, decreases spontaneous polarisation and increases coercive field values.



The $Pb_5Ge_3O_{11}$ single crystals pure and doped with Ba were measured by the XPS method. The changes in the full width at half maximum with the increase of Ba content were observed.

[1] H.H. Otto and P. Loster, Ferroel. Lett. **16** (1993) 81.
[2] B.A. Strukov, Ye.V. Siniakov, Ye. P. Maishtchik, K.A. Minaieva, V.G. Monia, O.G. Vlokh, Izv. AN SSSR, ser. Fiz. **41** (1977) 692.
[3] G. Burns, F.H. Dacol, W. Taylor, Phys. Rev. B **28** (1983) 253.

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