

Pure gyrotropic ferroelastic phase transitions in the materials PbMXO_4 ($M = \text{Ba, Sr}$; $X = \text{Si, Ge}$): a new piezoelectric family

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Gyrotropic phase transitions are characterized by the appearance of a spontaneous optical activity [1]. The appearance of such activity is very common in ferroelectric materials. In such materials, the optical activity is a secondary order parameter and is coupled to the primary order parameter which is the electrical polarization. However, only very rare examples are known of a pure gyrotropic phase transition. Among those, one can cite BiFeO_3 under strain [2] or $(\text{C}_5\text{H}_{11}\text{NH}_3)_2\text{ZnCl}_4$ as function of temperature [3]. In both cases, the transition exhibits a change from Pnma to $\text{P2}_1\text{2}_1\text{2}_1$ symmetry.

In this contribution, we have investigated materials belonging to the BaNdGaO_4 structural type (space group $\text{P2}_1\text{2}_1\text{2}_1$), of general formula PbMXO_4 ($M = \text{Sr, Ba}$; $X = \text{Si, Ge}$) using powder X-ray diffraction as function of temperature, second harmonic generation and piezoelectric properties. We present extensive studies on PbMGeO_4 and preliminary results on the Si doped systems. PbSrGeO_4 shows a 2nd order type phase transition towards a Pnma structure with metrically hexagonal phase. On the contrary, PbBaGeO_4 exhibits a first order phase transition, similarly to $(\text{C}_5\text{H}_{11}\text{NH}_3)_2\text{ZnCl}_4$, however with a phase competition between the high and low temperature phases over almost 200°C.

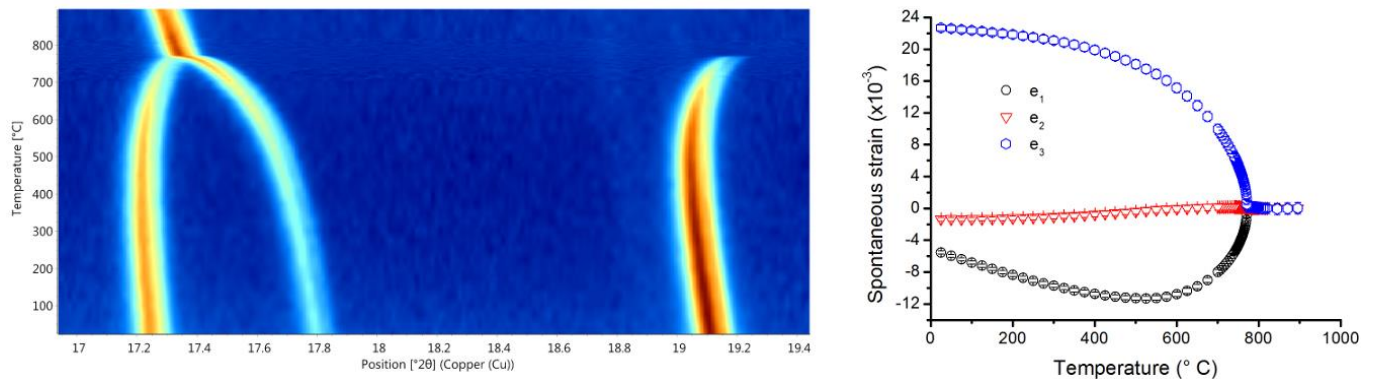


Figure 1: Temperature dependence study of PbSrGeO_4

Second harmonic generation and investigation of the piezoelectric properties demonstrated that this family is a new playground for new non-linear optical materials and identify the BaNdGaO_4 structural type as a new source for pure gyrotropic materials.

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