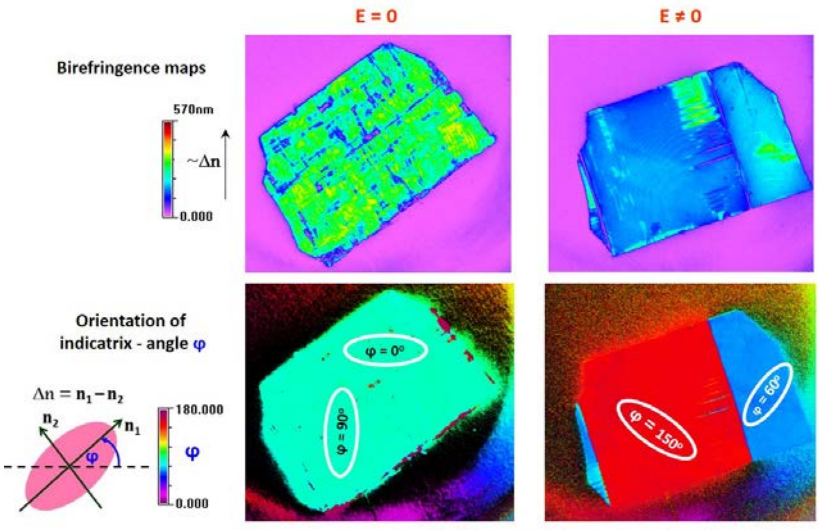
In today's world, nanotechnology is dominated by mobile phones and the entire/whole sphere of telecommunications to provide an example which is best visible. Although people in the field of physical sciences do not feel special (after all, we deal with single atoms, nuclei or elementary particles, a world much smaller than nano-size), the way to obtain such dimensions was undoubtedly a scientific challenge. It could be assumed that if $PbZr_{1-x}Ti_xO_3$ (known as the PZT) had not been discovered in the 1950s, today's nanotechnology would probably not have been existed. This was achieved, among other things, by building tunneling microscope and atomic force microscope in the 1980s, which utilized the excellent piezoelectric properties of PZT ceramics to build the so-called "actuators" to move the measuring element in the said microscopes (the so-called tip) on distances corresponding to the size of atoms. Today, PZT has a number of practical applications in microelectronics (transformers), medicine (ultrasound devices), sport (sports kits), and even in cars, to save fuel. Despite the decades that passed, PZT materials are mainly used in form of ceramics, and although easy to synthesize, they have a "granular" structure that is an obstacle to obtain a chemically homogeneous material.

For three years, we have been growing PZT crystals as the second team in the world with the use of technology developed in Military Academy of Warsaw, with Ti content of $0<x<0.5$. The first institution in that respect was Simon Fraser University in Vancouver, Canada. Recently, we have observed that under the influence of an electric field, a $PbZr_{0.95}Ti_{0.05}O_3$ crystal is strained by 0.3% in the. Until now, only Pb(Zn,NB)-$PbTiO_3$ or Pb(Mg,Nb)-$PbTiO_3$ crystals, called relaxors, have shown the deformation of a similar order. The important difference is that the same relative distortion (strain) for the $PbZr_{0.95}Ti_{0.05}O_3$ pre-tested crystal can be achieved in electrical field strengths up to ten times lower. This means that a potential difference of several volts, acting on a crystal of ten micro-meter size, will cause it to deform less than by 1pm. This 2mm*2mm*70µm crystal has shown to be also extremely resistant to the number of distortion cycles. It has not been mechanically destroyed even after two months of testing in electric fields with current strength of several kV/cm.

It appears strange that we do not know yet the exact physical mechanism that leads to such a strong deformation in both lead-free KNN, which are "competitors" for PZT (although they contain equally dangerous bismuth admixtures) and in relaxors or in PZT itself. In the case of relaxors, the lack of thorough understanding of this phenomenon may be due to their complex crystalline structure. The main reason for strong deformation in relaxors is assumed to be the electrical phase transition to the phase of tetragonal symmetry. Therefore, we are convinced that conducting studies of the PZT crystals with titanium content of $0<x<0.5$, which are simple ABO_3 perovskites, will help to understand this phenomenon and will allow us to verify the hypothesis that we have made. It relies on presumption that such strong deformations are related to the movement of ferroelectric domains, with the possibility of huge spontaneous polarization changes in the vicinity of the phase transition between the antiferroelectric and ferroelectric phases or between two different ferroelectric phases. These phase transitions are present in the PZT crystals we can grow, i.e. near the tricritical point (for $x<0.06$) and within the range of $0.06<x<0.5$. This would mean that the ultra-high deformation of PZT is rather not related to the movement of Pb ions around its positions in the ferroelectric unit cell, as proposed for crystals with the "famous" morphotropic phase boundary in the PZT compounds with Ti content around $x=0.5$. It appears to be mainly connected with the mobility of domains in co-existing phases with different polar order, i.e. with different symmetry. This project is therefore within the scope of basic research, but is also very pragmatic and has a wider perspective.

The figure on the right shows the ease of domains reorientations in d.c. electrical field in the $PbZr_{0.95}Ti_{0.05}O_3$ crystal from the region of tricritical point.



The complex map of the birefringence and the orientation of the indicatrix (E=0) changes clearly when the crystal is placed in the electric field (E ≠ 0).