Characterisation of Lead Titanate Single Crystals Grown by Self-Flux Technique

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Despite difficulties in manufacturing, lead titanate ($PbTiO_3$) remains a material of both scientific and industrial interest due to its enhanced tetragonality and Curie temperature (~490^{O}C) [1]. Phenomenological studies have been used to obtain the intrinsic material properties of lead titanate and demonstrate an enormous piezoelectric voltage coefficient (g_{33}) compared with other oxide perovskites [2]. However due to the large strain experienced at the cubic-tetragonal transition, sample size and therefore experimental data is limited. Although attention has now turned to the growth and commercialisation of relaxor-$PbTiO_3$ single crystals due to their large piezoelectric d_{33} coefficients, the large g_{33} and Curie temperature make lead titanate single crystals an extremely promising candidate for applications requiring a high voltage per unit stress or vice versa such as energy sensing and transducers.

Pure lead titanate crystals have been grown using the self-flux method. By adopting a double crucible set-up and using excess PbO as flux, relatively large, inclusion-free crystals have been successfully grown. Although the motivation behind the flux growth of these crystals is to aid in the study of more advanced crystal growth techniques, here x-ray diffraction and optical microscopy has been used to study the phase purity and to analyse the crystal morphology and domain structure of the samples, respectively.

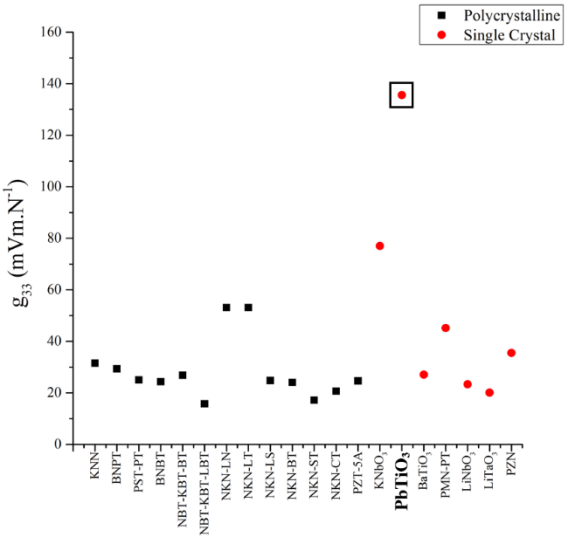

Figure 1: Piezoelectric voltage coefficient (g_{33}) for various materials in polycrystalline and single crystal form from throughout literature

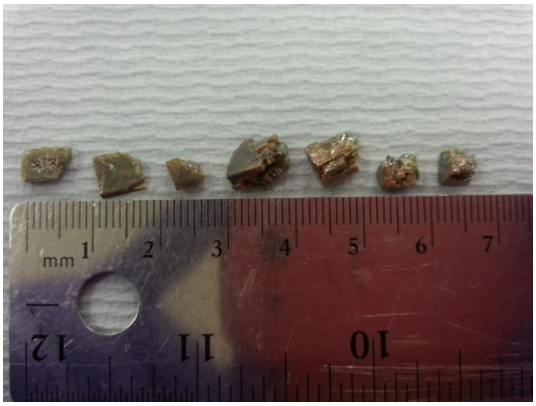

Figure 2: As-grown crystals of $PbTiO_3$

References

[1] – G. Shirane, S. Hoshino, K. Suzuki, *Physical Review* **80** (1950) 1105
[2] – M. J. Haun, E. Furman, S.J. Jang *et al.*, *Journal of Applied Physics* **62** (1987) 3331