



PROJECT BRIEF

Development of High Strain and High Coupling Piezoelectrics

Researchers: Shujun Zhang & Thomas R. Shrout

Background:

Piezoelectric ceramics are currently used in fuel injectors, NDT and high power ultrasonic systems. Future challenges in performance include the enhancement in piezoelectric strain and electromechanical coupling. Recently at Penn State, two innovations in piezoelectrics have occurred: 1) $\langle 100 \rangle$ domain engineered single crystals and 2) Novel high T_C MPB compositions in the $\text{Bi}(\text{Me})\text{O}_3$ -PT system. Single crystals offer significant improvement in piezoelectric performance ($d_{33s} > 2000\text{pC/N}$), and new high T_C MPB piezoelectrics have opened up a new temperature regime on the diagram (see Fig.1). In this work, new compositions with high $T_C > 300^\circ\text{C}$ and high piezoelectric performance have been identified in ceramics. It is expected further enhancement of the piezoelectric activity will be achieved in single crystal form by SSCG technique.

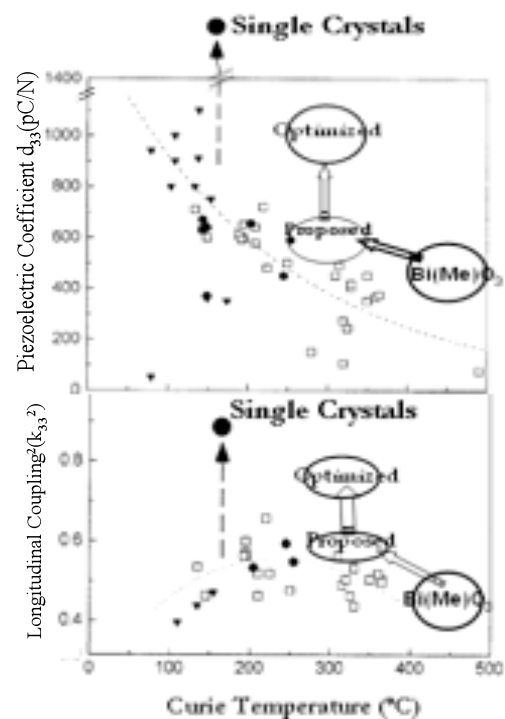


Fig.1. d_{33} and k_{33}^2 as a function of T_c

Project Tasks:

- 1) Identify MPB composition(s) in the ternary $\text{Pb}(\text{B}_1, \text{B}_2)\text{O}_3$ -PZ-PT and $\text{Bi}(\text{Me})\text{O}_3$ -PMN-PT systems with $T_{C_s} > 300^\circ\text{C}$.
- 2) Optimize piezoelectric properties by compositional tuning and microstructure/phase engineering.
- 3) Incorporate donor dopants strategies to enhance the “extrinsic” contribution to the piezoelectric properties i.e. “soft” materials..
- 4) Implement SSCG of $\langle 100 \rangle$ piezoelectric ceramics with $d_{33s} > 1000\text{ pC/N}$ and high coupling $> 80\%$.
- 5) Fabricate and test optimized piezoelectric materials for application in multilayer actuators, NDT and high power ultrasound transducers.

Center for Dielectric Studies

Materials Science and Engineering
 Pennsylvania State University
 University Park, PA 16802

For more information contact:

Thomas R. Shrout

Phone: (814) 865-1645; Email: tshrout@psu.edu

Shujun Zhang

Phone: (814) 863-2639; Email: soz1@psu.edu