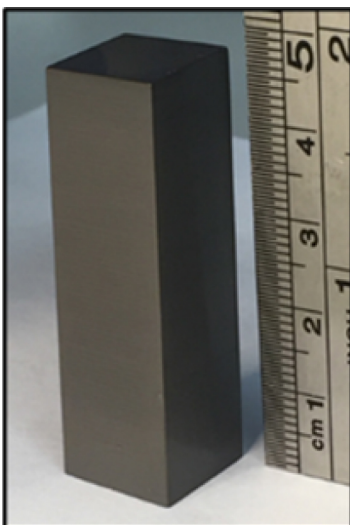


FEATURES

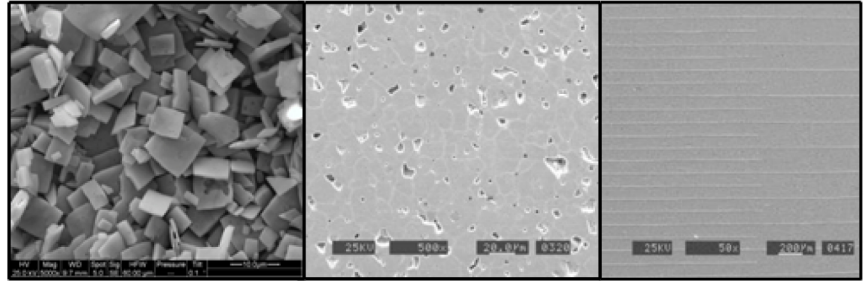
- Hybrid Solution
- Best of Soft PZT:
 - High d_{33}
 - High Coupling
- Best of Hard PZT:
 - Very Low Dielectric Loss
 - High Q_m

APPLICATIONS

- Hydrophones
- Underwater Projectors
- Energy Harvesting
- Multi-layer Co-fired Stacks
- Medical



Multilayer Co-fired Textured Piezoceramic Actuator with 0.2% Strain at 2V/ μm



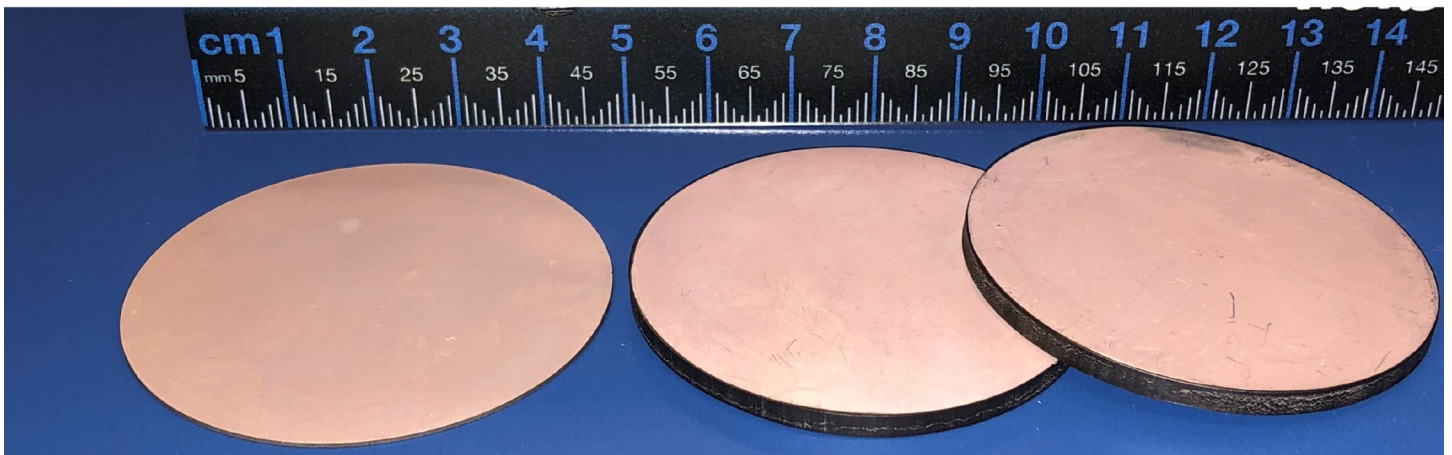
Micrographs of Seeds, Textured Microstructure, and Co-fired Stack

PROPERTY	UNITS	TX101
Mechanical Properties		
Density	ρ	g/cm^3 7.6
Compliances	S_{11}^E	$\times 10^{-12} \text{ m}^2/\text{N}$ 18.6
	S_{12}^E	$\times 10^{-12} \text{ m}^2/\text{N}$ 0.6
	S_{13}^E	$\times 10^{-12} \text{ m}^2/\text{N}$ -17.8
	S_{33}^E	$\times 10^{-12} \text{ m}^2/\text{N}$ 38
	S_{44}^E	$\times 10^{-12} \text{ m}^2/\text{N}$ 30
	S_{66}^E	$\times 10^{-12} \text{ m}^2/\text{N}$ 36.1
Electrical Properties		
Relative Dielectric Constant	K_{33}^T	1795
	K_{11}^T	1780
Dielectric Loss	$\tan\delta$	% 0.3
Piezoelectric Properties		
Coupling Factors	k_p	0.75
	k_{31}	0.56
	k_{33}	0.79
	k_t	0.58
	k_{15}	0.42
Charge or Strain Constants	d_{31}	$\times 10^{-12} \text{ m/V}$ -290
	d_{33}	$\times 10^{-12} \text{ m/V}$ 710
	d_{15}	$\times 10^{-12} \text{ m/V}$ 250
Voltage or Strain Constants	g_{33}	$\times 10^{-3} \text{ V m/N}$ 44.1
	g_{31}	$\times 10^{-3} \text{ V m/N}$ -18.4
Frequency Constants	N_p	Hz-m 1675
	N_t	Hz-m 1700
Mechanical Quality Factor	Q_m	350
Time Stability		
Aging Rate - Dielectric	α	% per decade -2.0
Aging Rate - d constants	α	% per decade -1.0
Aging Rate - Coupling	α	% per decade -0.6
Aging Rate - Frequency	α	% per decade 0.3

Typical Values measured at 20°C $\pm 1^\circ\text{C}$ are provided for design information only. Standard tolerances are approximately $\pm 20\%$ of these values. Material properties are measured according to IEEE standards and DOD definitions.

COMPARISON CHART

PIEZOCERAMIC TYPE	HARD	HARD	HYBRID	SOFT	SINGLE CRYSTAL
Material Name	K1000	K1300	TX101	3203	PIN Single Crystal
Material Type	PZT-8	PZT-4	Textured	PZT-5H	PIN24-PMN-PT
Piezoelectric Coefficient, d_{33} (pC/N)	230	280	710	530	1285
Electromechanical Coupling Coefficient, k_p	0.51	0.55	0.75	0.69	0.88 - 0.9
Piezoelectric Coefficient, d_{31} (pC/N)	-95	-120	-290	-270	-646
Mechanical Quality Factor, Q_m	1000	500	350	50	150
Dielectric Constant, K (ϵ_{33})	1000	1300	1795	3200	4753
Dissipation Factor, $\tan \delta$ (%)	0.4	0.5	0.3	2.0	<0.6



Textured Piezoceramic Disks

