Piezo Devices

superior performance through innovative engineering

Piezo Devices

Information Materials & Device Technologies, Electronics, Engineering Ltd.

PRODUCT CATALOGUE

piezodevices.com
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About Us

ENS Piezodevices Ltd. is a research spin-off company that designs, develops, manufactures piezoelectric materials, devices and systems for underwater sonar, biomedical ultrasound and in-air actuator applications.

The company is specialized in niche products and services such as;
- Piezoceramic and piezocomposite transducers with engineered shapes
- Finite elements modeling of piezoelectric transducers
- Piezoelectric ceramics with engineered microstructure
- Anisometric template powder particles with engineered morphology
- Lead based and lead-free piezoelectric ceramics with engineered compositions
- Project development and R&D consultancy

ENS Piezodevices Ltd. is committed to developing new technologies and providing innovative and custom engineered products. The company uses in-house developed, patent pending processes to fabricate some of these products.
Piezoelectricity is development of an electric polarization (i.e. charge) upon the application of a mechanical stress (in the form of pressure, vibration, sound, etc.). Conversely, it is the development of an induced mechanical strain (in the form of shape change, vibration, sound, etc.) which is directly proportional to an applied electric field.

Applications: Piezoelectrics are utilized in actuation, sensing dynamic pressure changes (sonar), changes in acceleration (from shock or vibration) and in force. Through proper design and selection of materials, the frequency range that piezoelectric materials can detect changes in force or motion can range from below 1Hz to above several MHz. Displacements in the µm range can be precisely measured as can force changes from mN to kN.

Limitations: Dimension, shape and materials’ properties are the most basic characteristics of a piezoelectric ceramic transducer determining the device performance. Piezoelectric ceramics are usually fabricated in simple shapes, such as plates, disks and rings, using conventional die pressing and tape casting techniques. However, bulk piezoelectrics have a low hydrostatic sensitivity, high acoustic impedance, narrow bandwidth and small strains.

ENS PIEZODEVICES LTD.’S APPROACH
The ideal way to overcome these problems would be to reliably obtain better electromechanical and electroacoustic performance from piezoelectric ceramic itself with built-in amplification mechanisms obtained through the shape and geometry of the transducer, i.e. Macrostructural Engineering.

Additionally, improving materials properties and obtaining single crystal-like performance along preferred directions can be achieved through the fabrication of crystallographically textured piezoceramics, i.e. Microstructural Engineering.
Engineered Geometries

**Spherical Omnidirectional Transducers**

A thin-walled hollow sphere transducer structure redistributes the stress and effectively amplifies incoming stress like a fextensionsal transducer, by a ratio of radius/thickness \((r/t)\) of the sphere to provide large hydrostatic piezoelectric charge coefficients. It provides an omnidirectional electroacoustic response. **ENS Piezodevices Ltd.** uses two different methods to fabricate spherical omnidirectional transducers operating in a wide frequency range from 50 kHz to 1 MHz.

**Specifications:**
- **Diameter (mm)**: 2.0 – 50.0
- **Wall thick. (mm)**: 0.1 – 3.0
- **Composition**: PZT \([\text{Pb(Zr,Ti)} \text{O}_3]\), PZN \([\text{Pb(Zn,Nb)} \text{O}_3]\), PMN \([\text{Pb(Mg,Nb)} \text{O}_3]\), KNN \([\text{(K,Na)} \text{NbO}_3]\), KSN \([\text{KSr}_2\text{Nb}_5\text{O}_{15}]\)

**Technical Reports**
Engineered Geometries

**Axisymmetric Hollow Shell Transducers**

Thin-walled hollow shells with axisymmetric geometry have the added benefit of multiple resonance frequencies with broader bandwidth. They provide an axisymmetric electroacoustic response that is omnidirectional in a plane perpendicular to the symmetry axis.

**Specifications:**
- **Diameter (mm)**: 2.0 – 50.0
- **Wall thick. (mm)**: 0.1 – 3.0
- **Length (mm)**: 2.0 – 100.0
- **Composition**: PZT [Pb(Zr,Ti)O₃], PMN [Pb(Mg,Nb)O₃], KNN [(K,Na)NbO₃]

**Technical Reports**
Engineered Geometries

Piezoelectric Ceramic Fibers

Piezoelectric ceramics in the fiber form are attractive due to their anisotropic properties and increased flexibility. Their main use is in the design and fabrication of compliant and flexible piezocomposite structures with high strain response and high acoustic sensitivity. The piezoceramic fibers are drawn using a novel technique developed by ENS Piezodevices Ltd.

Specifications:

- **Diameter**: 100 µm – 2 mm
- **Length (m)**: > 1
- **Composition**:
  - PZT [Pb(Zr,Ti)O₃],
  - PZN [Pb(Zn,Nb)O₃],
  - PMN [Pb(Mg,Nb)O₃],
  - KNN [(K,Na)NbO₃],
  - KSN [KSr₂Nb₅O₁₅]

Technical Reports:
Engineered Geometries

**Piezocomposites with 1-3 & 0-3 Connectivity**

Bulk piezoelectric ceramics have poor electtracoustic performance due to high acoustic impedance. Applications such as side-scan sonar, active vibration control and energy harvesting also require flexible piezoelectric transducers. The main solution proposed for these problems is the piezocomposite design where piezoelectric fibers or particles are embedded in a passive polymer matrix. **ENS Piezodevices Ltd.** have expertise in fabrication of 1-3 and 0-3 piezocomposites.

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**Specifications:**

- **Frequency range:** > 100 kHz
- **Composition:**
  - PZT [Pb(Zr,Ti)O₃]
  - PZN [Pb(Zn,Nb)O₃]
  - PMN [Pb(Mg,Nb)O₃]
  - KNN [(K,Na)NbO₃]
  - KSN [KSr₂Nb₅O₁₅]

**Technical Reports:**

Engineered Geometries

Spring and Helical Piezoceramic Actuators

Piezoelectric ceramic actuators are widely used due to their high efficiency, compact size, fast response time, and accuracy. However, piezoelectric strain in a piezoelectric bulk ceramic is usually limited to 0.2%. Piezoceramic actuators based on fiber springs and helical ribbons allow design and fabrication of compliant and flexible actuators with high strain response. The piezoceramic ribbons are drawn using a novel technique developed by ENS Piezodevices Ltd.

Specifications:
- Dia. or Thickness: 100 µm – 2 mm
- Length (m): > 1
- Ribbon Width (mm): 2.0 – 20.0
- Composition: PZT \([\text{Pb(Zr,Ti)O}_3]\), PZN \([\text{Pb(Zn,Nb)O}_3]\), KNN \([(\text{K,Na})\text{NbO}_3]\)

Technical Reports:

Vibration Modes of a Helical Ribbon

Green PZT Ribbon

Helical Ribbon Actuator

Hollow PZT Fiber Spring
Engineered Compositions

Lead Free Piezoelectric Powders & Ceramics

Lead zirconate titanate (PZT) ceramics are the most widely used piezoelectric materials. However, in the last decade use of lead containing materials even in electronic equipment are gradually being restricted due to the toxicity of lead. Thus, various lead-free alternative piezoelectric materials are being investigated for transducer applications. **ENS Piezodevices Ltd.** have expertise in synthesis of lead-free piezoelectric ceramic powders and bulk ceramics in a number of compositions.

**Specifications:**
Composition:
- KNN [(K,Na)NbO₃]
- KSN [KSr₂Nb₅O₁₅]
- BT [BaTiO₃]
- NBT [(Na,Bi)TiO₃]

**Technical Reports:**
Engineered Morphologies

Anisometric Template Particles

Anisometric template particles, i.e. microscale single crystal particles with non-equax morphology are used in the fabrication of crystallographically textured ceramics as templates. ENS Piezodevices Ltd. have expertise in the synthesis of anisometric template particles in a number of compositions.

Specifications:

Composition:  
NN [NaNbO₃]  
KSN [KSr₂Nb₅O₁₅]  
BiT [Bi₄Ti₃O₁₂]  
BaM [BaFe₁₂O₁₉]

Technical Reports:

Comparison of the structural and magnetic properties of submicron barium hexaferrite powders prepared by molten salt and solid state calcination routes, Ceram. Intern. 38 (5), 3801-3806 (2012).
Piezoelectric single crystals have superior properties but they are difficult and expensive to grow. Whereas, polycrystalline piezoelectric ceramics are easier and cheaper to produce but display inferior properties. The optimum solution is the fabrication of polycrystalline ceramics with grains oriented (textured) along special crystallographic directions to obtain single crystal-like superior performance in certain directions. Textured ceramics are usually fabricated by a combination of templated grain growth and tape casting, but these methods are not suitable for scaling up to mass production. ENS Piezodevices Ltd. developed a novel technique to mass produce textured ceramics in bulk forms.

**Specifications:**
- **Dimensions**: mm – cm
- **Composition**: KSN [K<sub>2</sub>Nb<sub>5</sub>O<sub>15</sub>], KNN [(K,Na)NbO<sub>3</sub>], PMN [Pb(Mg,Nb)O<sub>3</sub>]

**Technical Reports**
Engineered Designs

Finite Element Analysis of Transducers

Operating frequency and electromechanical performance of transducers are controlled by the properties of the material, as well as the shape and dimensions of the device. However, fine tuning the performance may require preparation and trial of numerous devices and countless failures. Use of finite elements modeling (FEM) in design and analysis of transducers greatly simplifies the development process. ENS Piezodevices Ltd. has extensive expertise in the use of FEM methods in transducer design and analysis.

**FEM Mesh of a Spherical Transducer**

**Comparison of FEM with Experiments**

**FEM Mesh of a Tonpilz Transducer**

**Capability:**
Static, harmonic and transient analysis of 2D, 3D, in-air and in-water electromechanical and electroacoustic performance of piezodevices

**Technical Reports**
Materials Synthesis in Thin Film & Nanoform

ENS Piezodevices Ltd. has a team experienced in synthesis and characterization of dielectric, piezoelectric and ferroelectric materials in thin film and in nanoforms using chemical (sol-gel, hydrothermal) and physical (magnetron sputtering) methods.

**Antiferroelectric Thin Films**

**Antiferroelectric Hysteresis Loop**

**Sol-gel Derived PZT Fiber**

**PZT Electrospun Nanofiber Mat**

**Capability:**
The company can develop customized recipes and provide consultancy in sol-gel synthesis of thin films and nanomaterials.

**Technical Reports**
Engineering

Advanced Ceramics in Standard Forms

ENS Piezodevices Ltd. has a team experienced in fabrication of advanced ceramics in various standard forms for electrical, structural and thermal applications. These include:

- PZT and lead-free piezoelectric ceramics in **disk** and **ring** form.
- **Alumina crucibles** in cylindrical, conical, boat and flat plate form.

Please contact us for other compositions and forms and we will provide you with customized solutions.

Services and Consultancy in R&D

ENS Piezodevices Ltd. can provide services and consultancy in the following areas:

- Consultancy in the development and preparation of R&D project proposals for TeknoGirisim, TUBITAK, KOSGEB, TEYDEB and European Union Framework Programs.
- Industrial partnership in San-Tez, TEYDEB and European Union Framework Programs.
- Preparation of customized recipes for materials synthesis.
- R&D scale synthesis of advanced materials in desired compositions.
- R&D scale fabrication of ceramics in desired forms and quantities.

Please contact us to discuss the details.
Contact

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