Piezoflex™ Polymer Transducers

Open New Opportunities

Piezoflex™ polymer is a new advance in PVDF transducer materials. Expand your transducer capabilities with our high performance, thick, sensitive piezoelectric polymer. We offer PVDF products from sheet stock to custom transducer assemblies.

AIRMAR
TECHNOLOGY CORPORATION

Large sheet of PVDF, shown coated with electroplated copper, typifies the standard size of PVDF in manufacture. Hydrophones with large surface areas can be fabricated from a single piece of PVDF, improving on previous technologies that group smaller elements together. The single sheet ensures uniform piezoelectric properties over the whole acoustic surface, as well as eliminates troublesome seams and gaps.

Flexibility of PVDF opens opportunities for many applications where conformal shapes are desired. Shown here are small rings a fraction of an inch in diameter and a curved wrist band. Shaped PVDF hydrophones possess the same piezoelectric sensitivity as flat sheet material yet permanently retain their shape to meet the needs of your applications.

Piezoflex™ polymer sensors

Piezoflex™ piezoelectric polymer enables you to create sensors for a wide variety of applications – in air, in marine, and for tactile sensing. This sensing material is manufactured by AIRMAR by a patented process using homopolymer PVDF (polyvinylidene fluoride). Key attributes of Piezoflex™ polymer are its thickness, high sensitivity, ruggedness, and low cost.

Transducer assembly and performance

Piezoflex™ polymer simplifies transducer fabrication. Lead wires are attached by soldering onto copper electrodes. Sensors can operate in a simple hydrostatic mode without needing "pressure release" on one or more sides. Performance is predictable, consistent from unit to unit, and free of unwanted spurious resonance modes.

Lightweight and tough

Piezoflex™ transducers can have a thin profile and are lightweight – perfect for portable applications such as diver communications. Its flexibility allows you to shape Piezoflex™ polymer to fit a prescribed contour. And its physical robustness means Piezoflex™ sensors can withstand rough handling.

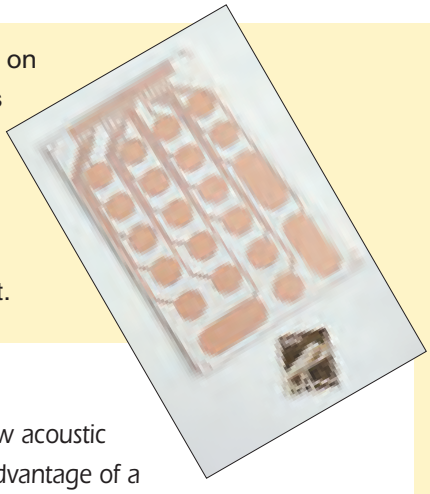
Accurate beam patterns

With Piezoflex™ polymer, you can create a variety of beam shapes by etching electrode patterns. You can optimize the beam shape for the space available for the transducer, obtaining the best beamwidth together with the lowest sidelobe levels in the least space. In applications detecting targets near the water surface, you can suppress sidelobe levels to reduce extraneous surface clutter.

Arrays of elements etched on a single sheet of PVDF embody the intrinsic uniformity of the sheet – providing element responses well matched in amplitude and phase. Elements can be designed for specific beam profiles and, further, can be created without physically dicing the polymer.

Air transducers, shown here at 250 mm in diameter, can satisfy applications requiring accurate sighting of a target using a very narrow acoustic beam. The large radiating surface attainable with thick PVDF is physically robust and tolerant of adverse environments.

Keypads and tactile sensors on PVDF eliminate common problems associated with make/break metal contacts. Piezoflex™ transducers produce a voltage (proportional to the force applied) in an uninterrupted electrical circuit.



Intricate electrode patterns on PVDF, illustrated as a nested set of ellipses in this photo, are created by standard low-cost PCB etching techniques. This pattern produces an elliptical acoustic beam with very low sidelobes in all directions.

Narrow acoustic beams

When your acoustic system requires a narrow acoustic beam, Piezoflex™ transducers provide the advantage of a large radiating surface at low assembly cost. Narrow beams are especially useful for level sensing, bottom mapping, surveying, and multibeam applications.

Industrial air transducers

Piezoflex™ air transducers perform comparably to ceramic-based devices in both transmit and receive operation, yet offer increased versatility. You can specify beam width and frequency independently, and you can specify narrow beams with low sidelobes to reduce false targets. Ranging in a confined area, such as a grain silo, is an example of where these attributes are beneficial.

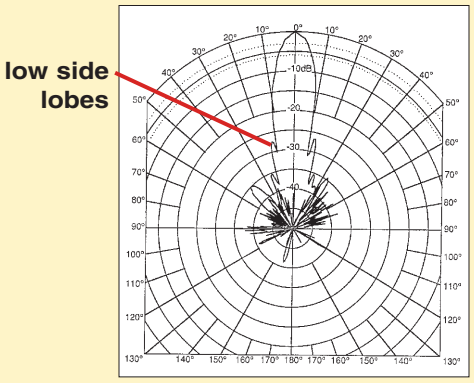
Wide frequency bandwidth

Piezoflex™ sensors can operate over broader bandwidths than many other piezoelectric materials because they operate in a non-resonance mode with intrinsically low Q. High-fidelity reception and spread spectrum schemes, such as waveform coding or pulse compression, can be implemented with Piezoflex™ transducers. These capabilities are useful in shallow water applications when you need to overcome problems of acoustic "fading" in multipath environments.

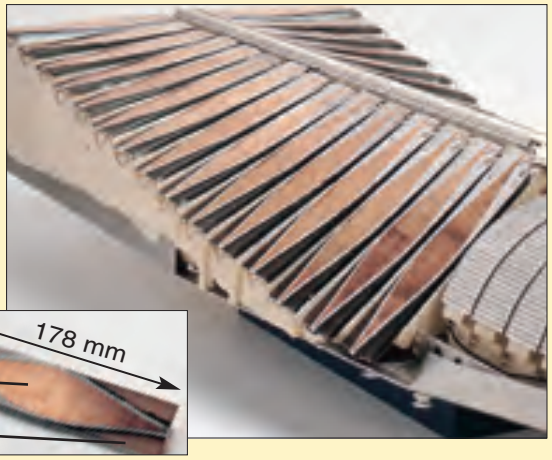
Price

Piezoflex™ polymer is much lower in cost per unit than piezoceramics. When Piezoflex™ polymer is incorporated into transducers, the ease of design, manufacture, and assembly provides a low cost sensor for your application.

Low sidelobes, difficult to achieve by other technologies, are consistently achieved in practice with PVDF. This experimental beam plot exhibits sidelobe levels more than 26 dB below the main beam.



This multibeam transducer, used in swath bathymetry systems, employs individual Piezoflex™ hydrophones each tilted a few degrees from its neighbor, as shown here. This transducer with its 30 adjacent beams enables the survey of a large area of the sea bottom on a single pass of a vessel. The low sidelobes and well-controlled shape of each beam minimize interference between adjacent beams.



Piezoflex™ Performance Specifications

Property	Value	Notes
Hydrostatic voltage sensitivity (M_o)	-197.2 dB re 1V/µPa	1
Hydrostatic charge sensitivity (d_h)	-18 pC/N	
Charge sensitivity in stretch direction (d_{31})	+14 pC/N	2
Charge sensitivity in orthogonal direction (d_{32})	+2 pC/N	2
Charge sensitivity in thickness direction (d_{33})	-34 pC/N	2
Relative dielectric constant (κ')	7.6	3
Dielectric loss tangent (tan δ)	0.015 at 1kHz	4
Capacitance (C)	130 nF/m² (83 pF/inch²)	
Thickness (t)	0.50 mm (0.020 inches)	
Density (ρ)	1.47 x 10^3 kg/m³	
Young's modulus ("3" direction) (Y_{33})	900 MPa	5
Maximum exposure temperature (T_{max})	90°C (194°F)	6
Maximum operating pressure (P_{max})	7 MPa (1,000 psi)	7
Maximum drive voltage (V_{max})	±45 kV	8

Notes

1. The term "hydrostatic" indicates that acoustic pressure is exerted on all sides of PVDF (without pressure release or clamping on any side).
2. These tensor coefficients represent charge collected on the electrodes when PVDF is stressed along a single direction. The "1" direction is the process (or so called "stretch") direction. The "2" direction is the in-plane direction orthogonal to the process direction. The "3" direction is the thickness direction. The first subscript indicates that the charge is collected on the large surface area (perpendicular to the "3" direction). The second subscript indicates the direction of the applied stress.
3. Equal to an absolute dielectric constant of 67.2 picoFarads per meter.
4. Loss tangent changes with frequency, gradually increasing as frequency is raised. Contact Airmar for detailed graphs.
5. Young's modulus is anistropic. In-plane directions have higher moduli than the thickness "3" direction. In the stretch direction: 2.5 GPa; orthogonal to stretch direction: 2.1 GPa.
6. PVDF can be exposed to this temperature for an indefinite length of time without degradation in properties.
7. In addition, PVDF survives pressure to 14 MPa with 1 dB (permanent) reduction in sensitivity.
8. Dielectric breakdown begins to occur for voltages above 70 kV (150 MV per meter).

Airmar Today

Airmar Technology Corporation, the leader in ultrasonic transducer technology, is proud of its reputation for manufacturing marine and industrial sensors in large quantities at a low cost. In addition to volume production for OEMs, Airmar provides extensive engineering support. The company currently holds nineteen U.S. and foreign patents and was the recipient of the 1991 IMTEC Innovation Award.

Since its founding in 1982, Airmar has introduced unique and popular new products ranging from speed sensors for personal watercraft to multibeam arrays for swath bathymetry. Airmar welcomes inquiries from manufacturers for custom designs. The company currently has 135 employees and occupies a new 75,000 square foot facility with three acoustic test tanks.

AIRMAR
TECHNOLOGY CORPORATION
35 Meadowbrook Drive, Milford, New Hampshire 03055-4613 USA
Phone (603) 673-9570 ▪ FAX (603) 673-4624
e-mail:sales@airmar.com ▪ http://www.airmar.com

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