

POLYMER TRANSDUCERS

In 1969, Kawai⁶⁹ discovered that polyvinylidene difluoride (PVDF, PVF₂), which is an organic ferroelectric polymer, displayed strong piezoelectric properties. In the last decade, an organic copolymer known as polyvinylidene difluoride trifluoroethylene P(VDF-TrFE) with a higher coupling coefficient has become available. These polymers are used in hydrophones, audio microphones, and robotic tactile transducers. In addition, they find application in wave-propagation transducers for NDT, medical imaging, hi-fi stereophones, and tweeters. Table shows the piezoelectric and related properties of these copolymers.

Property	PVDF	P(VDF-TrFE)	P(VDF-TeFE)	P(VDCN-VAc)
Dielectric constant ϵ_r at 1–10 MHz	6.0	5.0	5.5	6.0
Dielectric loss tangent, $\tan \delta$, at 1–10 MHz	0.25	0.12	0.20	N/A
Mechanical Q , $1/\tan \delta_m$	10	25	15	N/A
Stiffness constant c_{33}^D (10^9 N/m ²)	9.1	11.3	9.2	8.2
Electromechanical coupling, k_t	0.20	0.30	0.21	0.22
Density (10^3 kg/m ³)	1.78	1.88	1.90	1.20
Sound velocity, m/s	2200	2400	2200	2620
Acoustic impedance, Z_0 (10^6 kg/m ² s)	3.9	4.5	4.2	3.1
Piezoelectric h_{33} (10^9 V/m)	-2.6	-4.7	-2.9	-2.6

A hydrophone is a very sensitive pressure transducer that is used to map the temporal and spatial acoustic pressure field of another transducer that is propagating acoustic energy through a fluid.

Hydrophones have to satisfy many requirements: low acoustic impedance to optimally match the fluid impedance and cause the least disturbance to the field being measured, small sensing spot size to obtain good spatial resolution, large bandwidth and flat frequency response to respond to harmonics of the measured signal, and good linearity to handle the wide dynamic range of pressures.

Two types of hydrophones most commonly used are the membrane hydrophone and the Lewin-type needle hydrophone.

In the membrane hydrophone, a metallized 250- to 500- μm -diameter circular dot is vacuum-deposited on either side of a poled copolymer film using a simple mask. This results in a single-element dot transducer. Suitable connections are made to the dots by vacuum-deposited metallic traces. The copolymer is then stretched and held in position over a circular hoop. The pressure of the acoustic field is measured as the electrical output of the dot transducer.

The needle hydrophone consists of a poled, 0.5- to 1.0-mm-diameter, PVDF or copolymer film transducer which is bonded to the flattened end of a hypodermic needle but electrically insulated from it. The electrical output of the transducer gives a measure of the acoustic field pressure.

Source: <http://mediatoget.blogspot.in/2012/06/polymer-transducers.html>