Ultrasonic PVDF transducer for 3-4 MHz operation

R H Brown 13 September 2001

In response to a customer enquiry, a device has been assembled and tested which demonstrates good efficiency in the frequency band 3 to 4 MHz. The device comprises two layers of 110 µm PVDF with printed silver ink electrodes on each side of each film. The presence of the silver ink changes the ultrasonic response "expected" from two layers of pure PVDF – the center frequency is reduced from 5 MHz down to 3.75 MHz, and the Q-factor is slightly higher (3.6 versus 3.0 for no ink).

The parallel connection of two elements (each 12.5 x 30 mm in size) gives a device capacitance of 770 pF, and therefore approximate impedance of 55 ohms at 3.75 MHz (actually expected to be somewhat higher, as the permittivity of PVDF will be lower at this frequency). An impedance on this order will give very good results with conventional NDT or other ultrasonic test equipment (efficient matching of drive electronics to load, and load to receiver electronics).

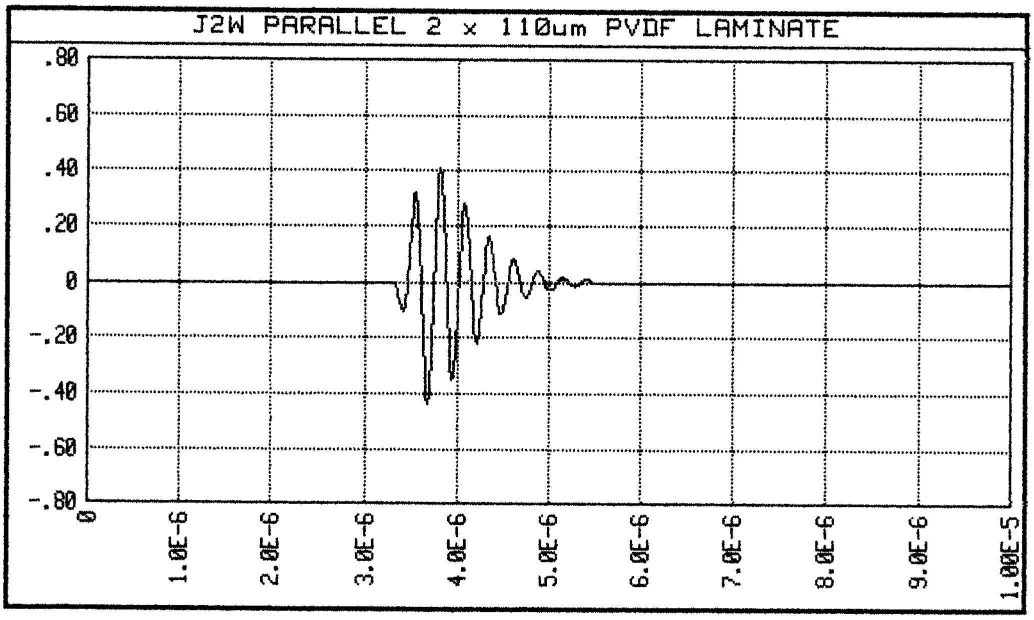
The two elements were each around 136 µm total thickness prior to lamination, and were glued "signal face inwards" to each other using 5-minute epoxy resin. The total thickness of the laminated device was 276 µm, indicating a rather thin epoxy layer of 4 µm thickness.

The individual elements had been printed using the pattern generated for FDT1-028K w/adh sensors (MSI p/n 0-1001777-0), but on non-standard thickness PVDF and omitting the adhesive tape layer. This pattern is not quite ideal for bonding in this configuration, as the signal and ground traces extending away from the active area then lie over opposite polarity traces – a minor revision to this pattern (or using one "normal" and one mirror-image pattern) would allow "same polarity" overlay, and thus also allow for easy termination to same two-pin connector.

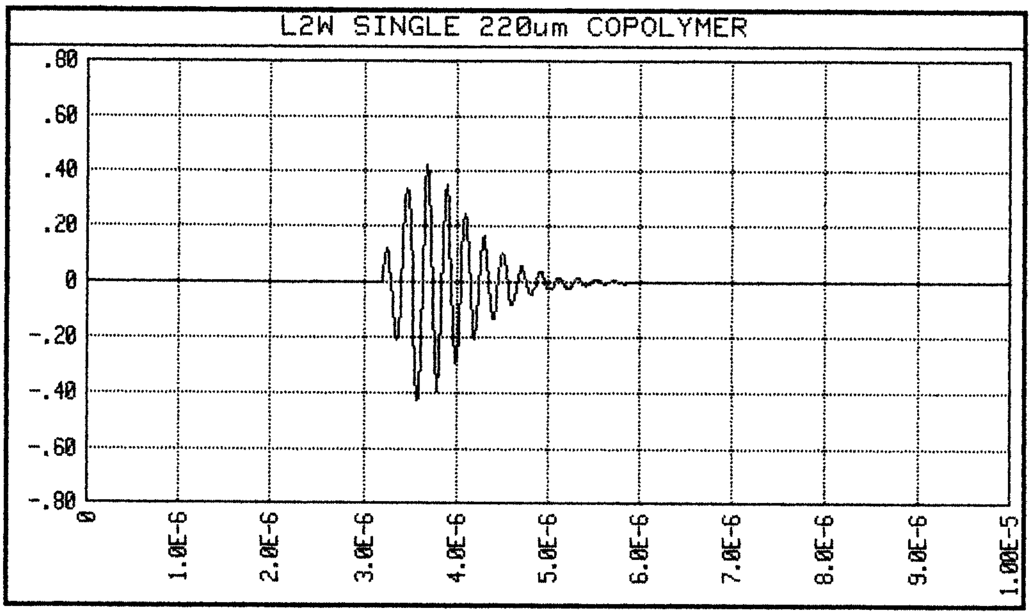
The trace attached shows the response obtained when the device was driven using a standard pulser/receiver (Accu-Tron model 1035 PR), with the transducer coupled via a thick layer of silicone gel to an aluminum reflector surface. The signal for a single thickness of p(VDF-TrFE) copolymer, with sputtered metallization on each surface, is also shown for comparison. FFT results from these traces are also presented

Pulser settings for this test: gain 20 dB, attenuation –10 dB (therefore overall gain +10 dB), energy setting 1, damping setting 5.

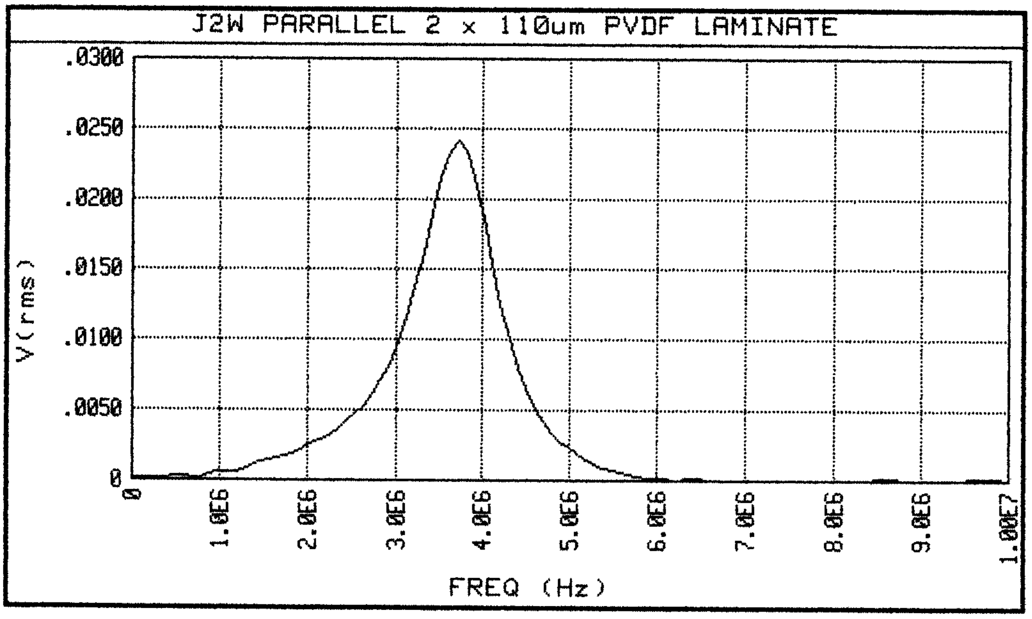
The observed signals from the PVDF device are very strong, and of very similar magnitude to the copolymer material with sputtered metallization. Generally, copolymer shows a 2 to 3 dB advantage in each direction (transmit and receive), so the parity of signal strength is at first somewhat surprising. The advantage is most likely due to the lower electrical impedance of the PVDF device, and thus improved matching to the drive circuitry.

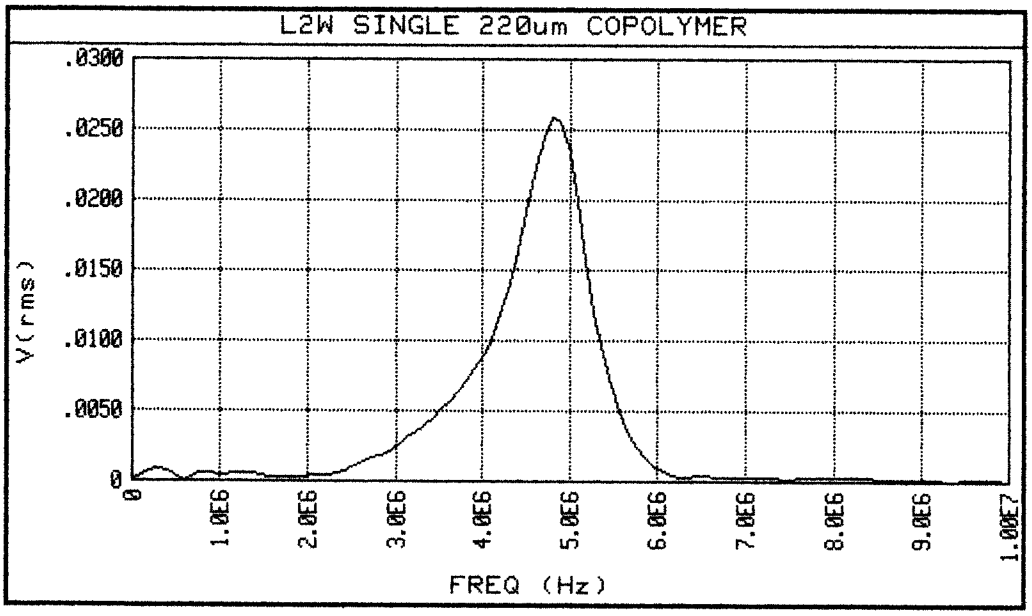


MIN: -.434 MAX: .413 Pk-Pk: .847



MIN: -.427 MAX: .427 Pk-Pk: .854


J2W PARALLEL 2 x 110um PVDF LAMINATE
V(rms)
.0300
.0250
.0200
.0150
.0100
.0050
0
0
1.0E6
2.0E6
3.0E6
4.0E6
5.0E6
6.0E6
7.0E6
8.0E6
9.0E6
1.00E7
FREQ (Hz)


L2W SINGLE 220um COPOLYMER
V(rms)
.0300
.0250
.0200
.0150
.0100
.0050
0
0
1.0E6
2.0E6
3.0E6
4.0E6
5.0E6
6.0E6
7.0E6
8.0E6
9.0E6
1.00E7
FREQ (Hz)

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