

Energy Generation using Piezo Film (III)

Thermal Destruction of Piezo Film

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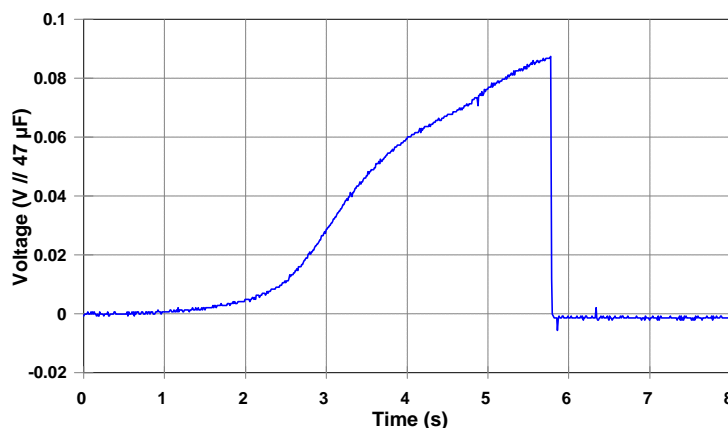
An LDT0 element (MSI p/n 0-1002794-0) was connected in parallel with a 47 μF capacitor, and then heated with a hot-air gun until the element broke down (when the silver ink electrodes formed a short-circuit through voids appearing in the PVDF material). The voltage across the 47 μF capacitor was monitored using a 10 M Ω oscilloscope probe, which formed an R-C time constant of 470 seconds. The destruction event lasted about 6 seconds, and so the error during the measurement due to leakage of charge was very small.

A peak voltage of 88 mV was recorded, equivalent to 4.14 μC charge.

The initial capacitance of the piezo element was 545 pF. Had this quantity of charge been allowed to remain on the sensor, then the open-circuit voltage would have been $Q/C = 7596$ V. In reality, electrical discharge through the dielectric would have occurred well below this level (probably at around 2500 V for the 28 μm PVDF thickness). Nevertheless, if we assume for a moment that the full potential could be sustained, we would have a stored energy ($\frac{1}{2}CV^2$) of 15.7 mJ.

This theoretical energy level is developed using a volume ($l \times w \times t$) of 4.2×10^{-9} m^3 . Converting this into a specific (volumetric) figure gives 3.7 MJ/m^3 - considerably in excess of values recorded from real-world piezoelectric tests (e.g. 0.2 MJ/m^3 from detonator experiment, using efficient transformer coupling to 22 μF capacitor, with film taken close to but below the destruct limit).

This experiment suggests that a high "potential" energy is available from piezo film, but that the dielectric strength of the film limits this quantity severely. If we recalculate the energy based on a maximum of 2500 V across the film element, we see stored energy of only 1.7 mJ, which equates to 0.4 MJ/m^3 - much closer to the value obtained in the detonator experiment.



The graph shows the voltage recorded across the 47 μF capacitor as the film element was destroyed by heating.

Peak V = 88 mV approx.

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