EXPANDING on the CONCEPTS

Voltage arises from the movement of electrons within the PVDF film, and voltage can vary with different stresses. Read here to find out why your experiments worked the way they did, and how heat causes a pyroelectric response.

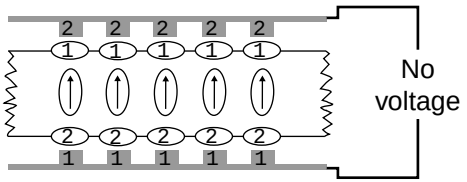
A piezoelectric material generates a spurt of charges when stressed. As you have seen, this is because stress causes a change in the distribution of charges in the film. When surface charges change, electrodes next to each surface gain or lose electrons in order to restore neutrality of charges in the sensor film.

When a mechanical force acts on the PVDF film, the voltage produced is directly proportional to how much and how rapidly the film is deformed. The greater the deformation of the film, the higher the voltage will be.

To understand this, imagine dropping a bowling ball onto a wooden table top. The table top is deformed just where the ball hits. Now imagine dropping the same bowling ball onto a trampoline. The impact causes the entire trampoline to sag or stretch. The trampoline shows a greater amount of mechanical deformation (stretching or pulling, in this case) than the wooden table.

Consider these ball drops as an analogy for what happens to piezoelectric film. In the case of a straight ball drop test, with the film taped to a rigid surface so that the force acts to compress the film's thickness (A), the force is exerted only over the area under impact and the electrical charge is small. However, if you place the same film on top of a pliable substrate, you see a significant increase in the voltage response. The ball's impact now causes greater mechanical deformation in the film, and this results in a much larger output voltage.

Piezoelectric polymer films are also pyroelectric. As PVDF film absorbs thermal energy (as in a motion detector), it will expand (B) and contract in response to the thermal gradient developed. This redistributes electrical charges in the film, which generates voltage.



An unstressed polarized PVDF film. Close-up of film surfaces and electrodes.