

## Piezotech Processing Guide

### - Piezotech FC - Calculations -

#### Deformation under electrical field

The deformation caused by the applied electric field can be defined by the simple formula:

$$S_i = d_{3i} E \quad i=1;2;3$$

Where

- $S_i = \Delta x_i / x_i = \Delta L / L$  and represents the strain (relative deformation) of the sample in the  $x_i$  direction
- $d_{31}$  is the piezoelectric strain constant

Example of an element with the following characteristics:

Length:  $l=1\text{cm}$

Width:  $w=2\text{mm}$

Thickness:  $t=9\mu\text{m}$

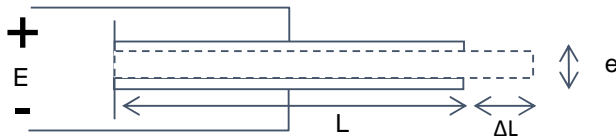
Applied voltage:  $V=200\text{V} \rightarrow E$  (electric field) =  $V/t$

The piezo strain constant  $d$  is given by:

$$d = \frac{\text{strain developed}}{\text{applied field}} = \frac{S}{E}$$

$(d_{31}, d_{32}, d_{33}) = (11, 10, -30) \text{ pC/N}$

$$\Delta L = d_{31} * \frac{V}{t} * L = 2.44 \mu\text{m}$$



#### Sensors: Orders of Magnitude, Voltage generation

The electrical field output ( $E$ ) caused by an applied force can be defined by:

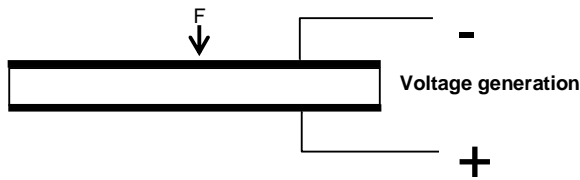
$$E = g_{ij} \sigma_i$$

Where:

- $\sigma_i$  is the applied mechanical stress ( $\text{N/m}^2$ )
- $g_{ij}$  is the piezoelectric voltage constant ( $\text{Vm/N}$ )

$$g = \frac{\text{electrical field developed}}{\text{applied mechanical stress}} = \frac{E}{\sigma}$$

$(g_{31}, g_{32}, g_{33}) = (216, 19, -339) * 10^{-3} - \text{Vm/N}$



Example of an element with the following characteristics:

Length:  $l=2\text{cm}$

Width:  $w=2\text{cm}$

Thickness:  $t=100\mu\text{m}$

Compression 0.1 Bar (104 Pa) 4N ->  $\sigma=10000\text{N/m}^2$

$$E = \frac{V_0}{t} = g_{33} \sigma_3$$

$$V_0 = g_{33} \sigma_3 t = 339\text{mV}$$

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