

Resistive sensors

Material from

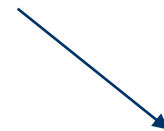
- Section 3.5: Resistivity
- Section 9.5: Strain gauges
- Chapter 10: Pressure sensors
- Chapter 18: Micromachining and silicon
- Section 5.9.1: Noise
- Chapter 5.7: Bridge circuits

Hvorfor

Noe vi vil måle



Mekanisk
spenning
(strain)



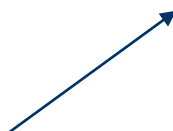
Motstandsending

Elektrisk
spenning

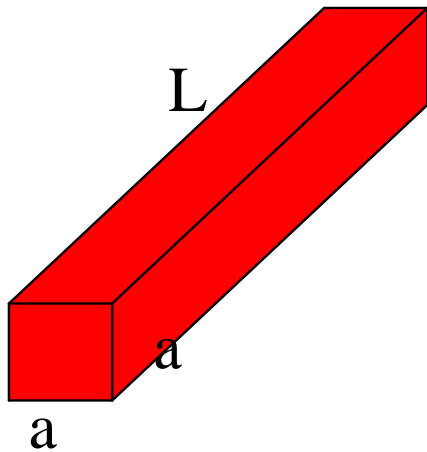
Temperaturendring



Noe annet vi
vil måle



Resistivity



$$R_0 = \rho L/a^2$$

Mass

$$\rho = \frac{m}{ne^2\tau} \quad (3.53)$$

Time between collisions

Carrier density

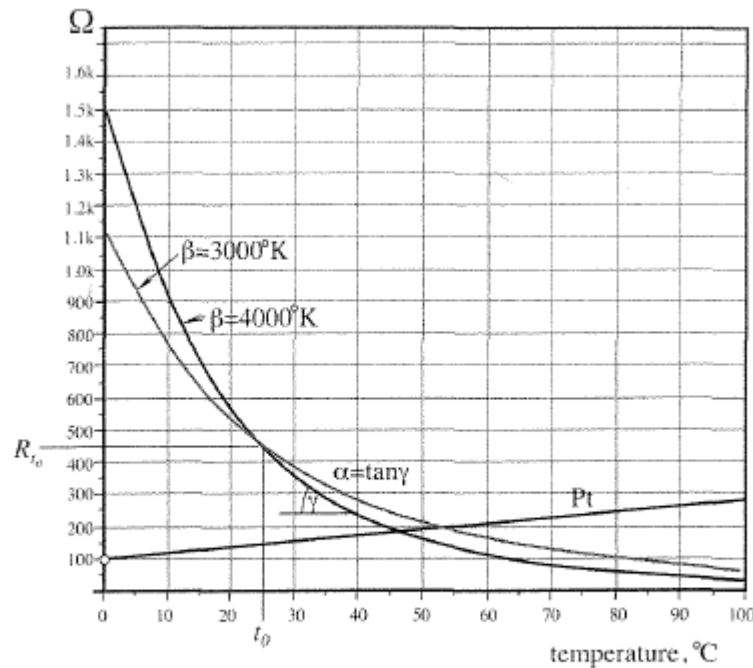
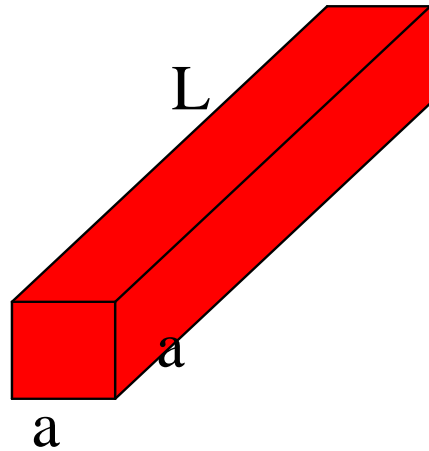


Fig. 3.18. Resistance–temperature characteristics for two thermistors and Pt RTD ($R_0 = 1k$); thermistors are calibrated at $t_0 = 25^{\circ}\text{C}$ and RTD at 0°C .

Begrep

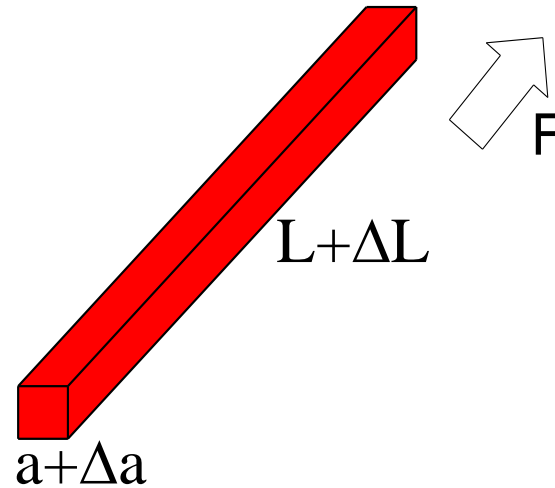
- Resistive thermal detector (RTD)
- Pt 100
- Thermistor
- Temperature coefficient of resistivity (TCR)
- Negative temperature coefficient (NTC)
- Positive temperature coefficient (PTC)

Motstandsending i metall leder



$$R_0 = \rho L/a^2$$

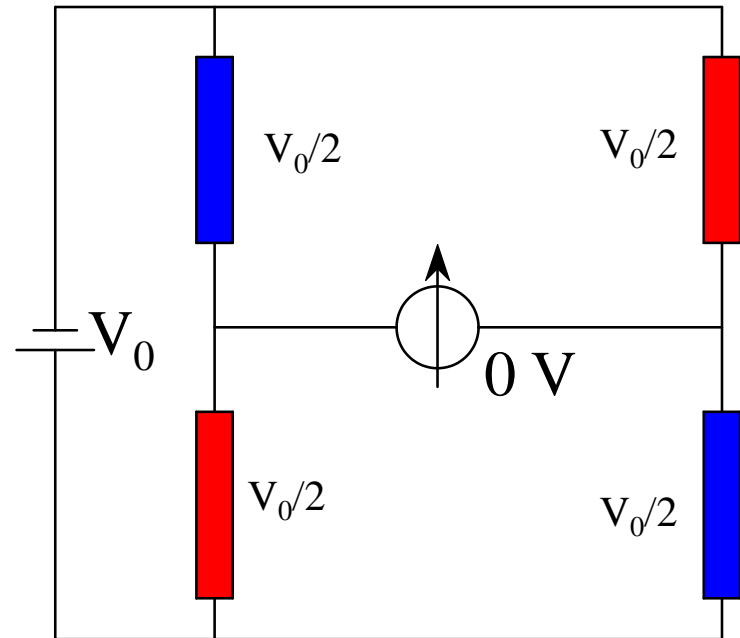
$$\Delta a/a \approx -1/2 \Delta L/L$$



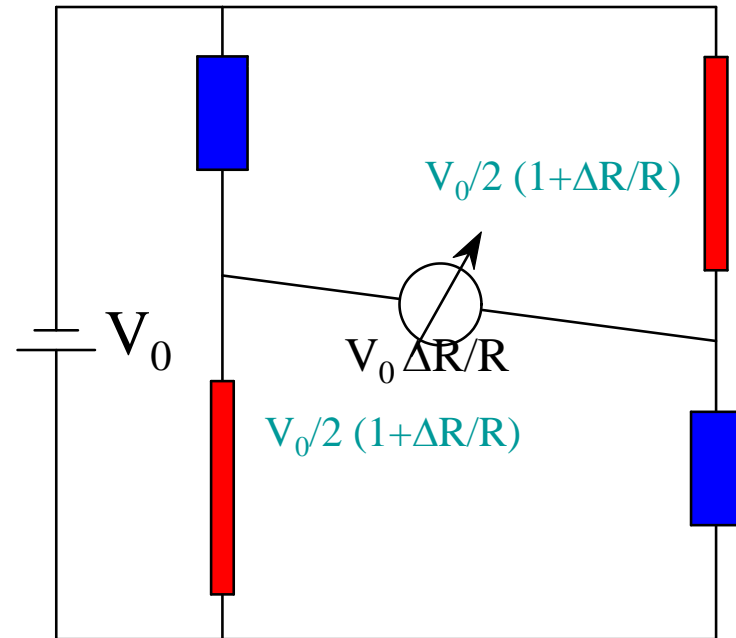
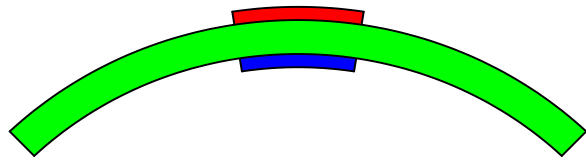
$$R = R_0 + R_0 \Delta L/L - 2R_0 \Delta a/a$$

$$\Delta R/R \approx 2 \Delta L/L \quad \Delta R/R \approx 2 \epsilon$$

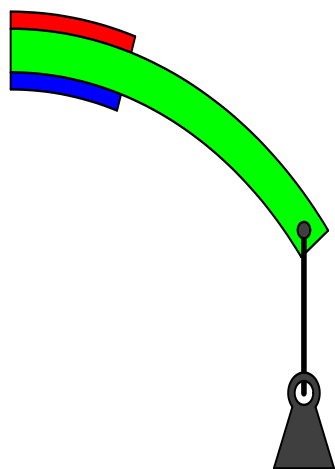
Balansert bro



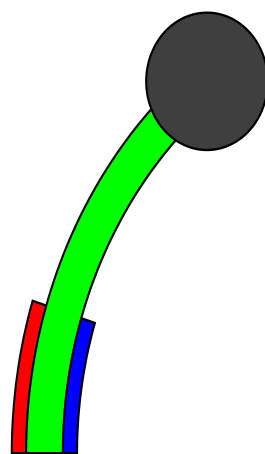
Belastet struktur



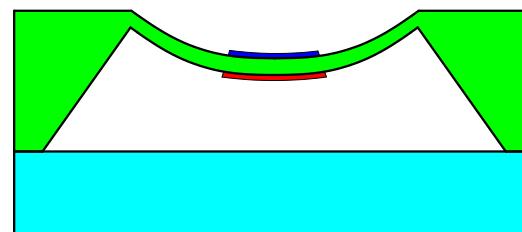
Bruksområder



Veieceller



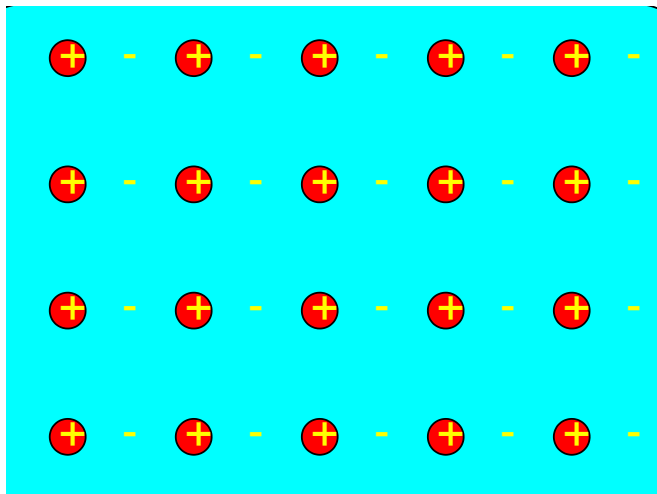
Akselerometer



Trykksensorer

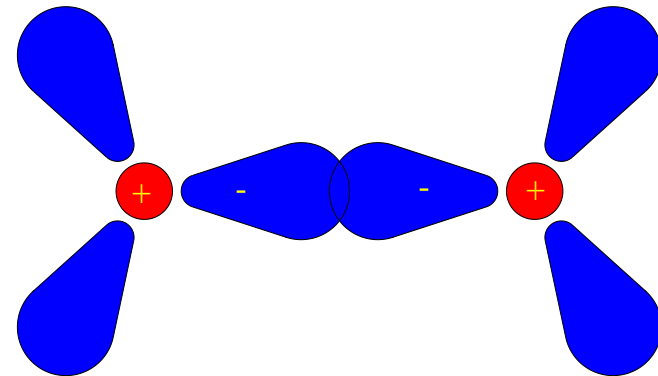
Forskjell i gauge faktor

Metall:



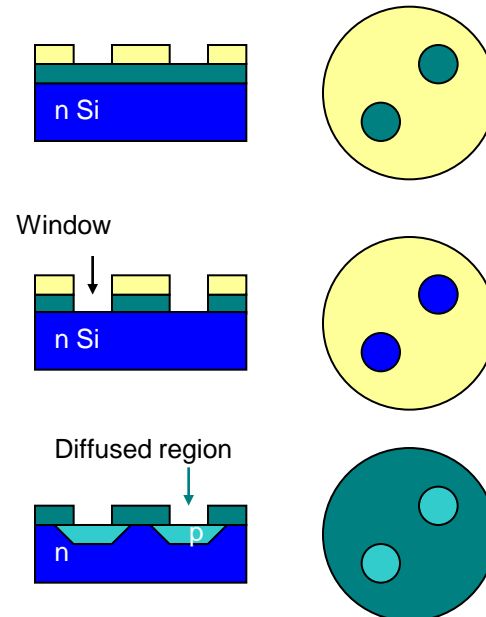
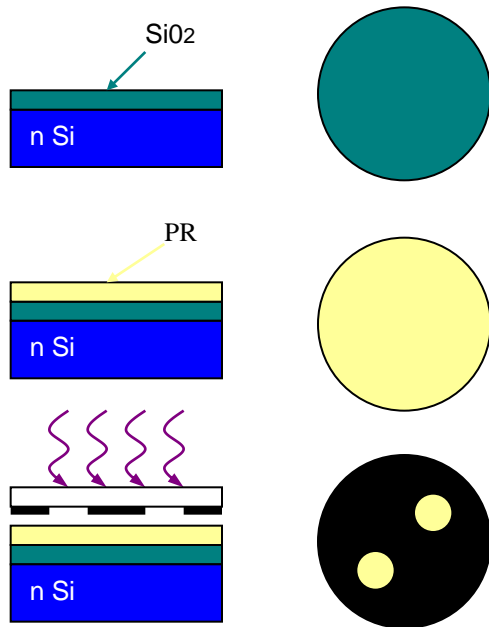
$$\Delta R/R \approx 2 \varepsilon$$

Silisium:

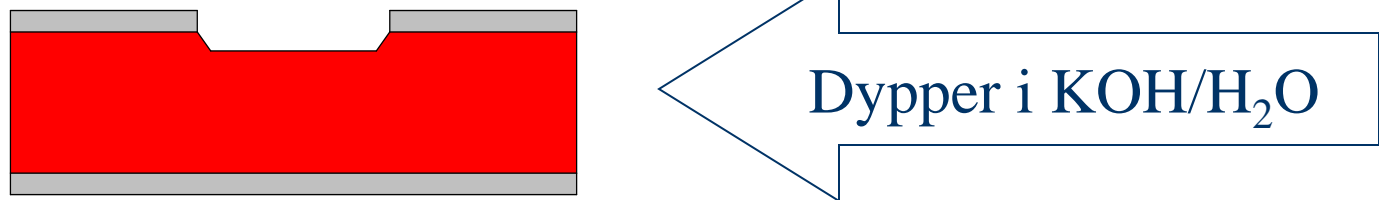
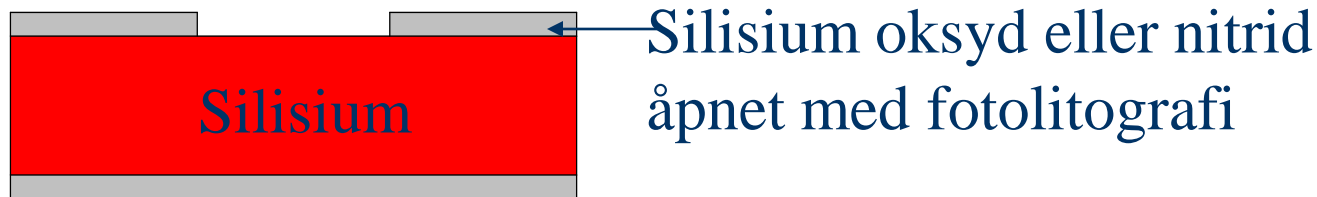


$$\Delta R/R \approx 90 \varepsilon$$

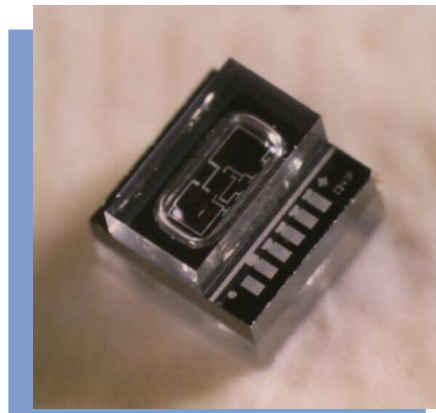
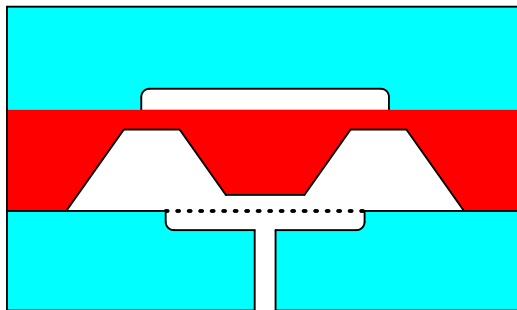
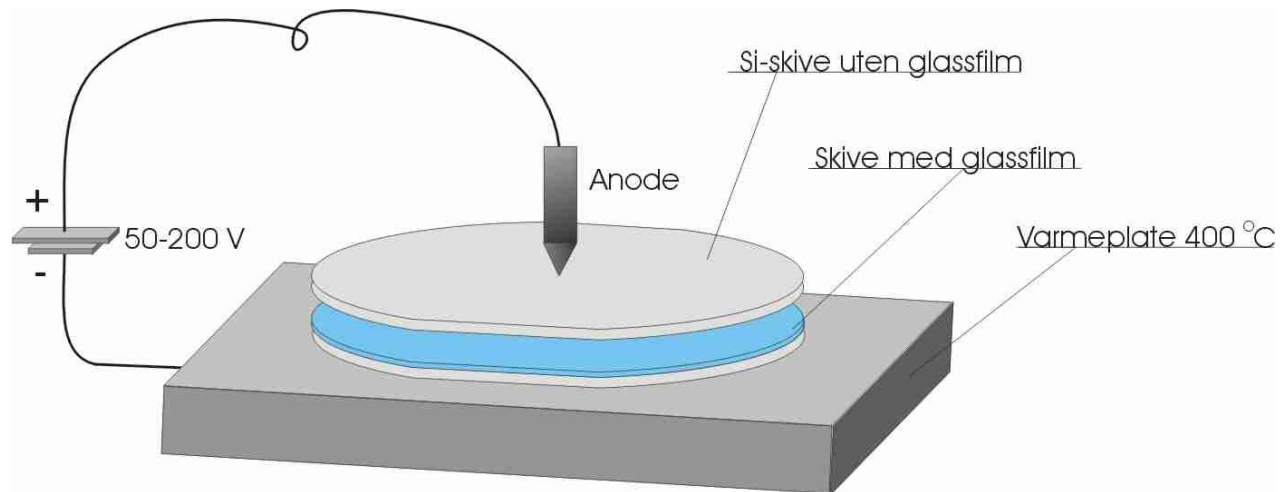
Fotolitografi



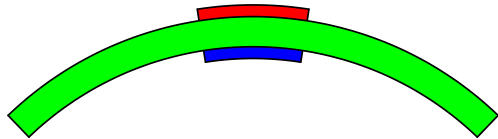
Anisotrop våt etsing



Anodisk bonding

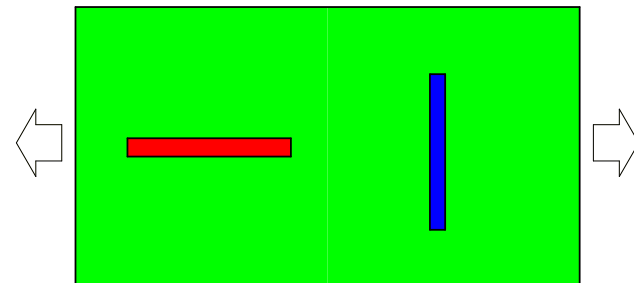
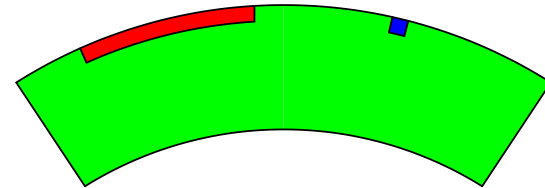


Retningsavhengighet



Over/under konfigurasjon
er ikke praktisk i silisium.

Men vi kan snu retningen
på motstandene



Piezoresistiv trykksensor

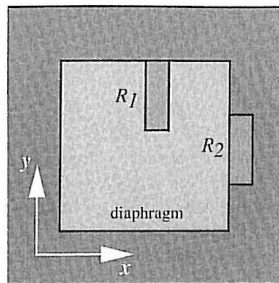
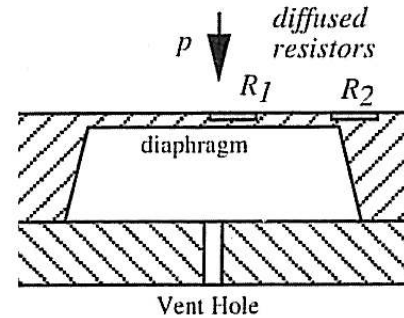
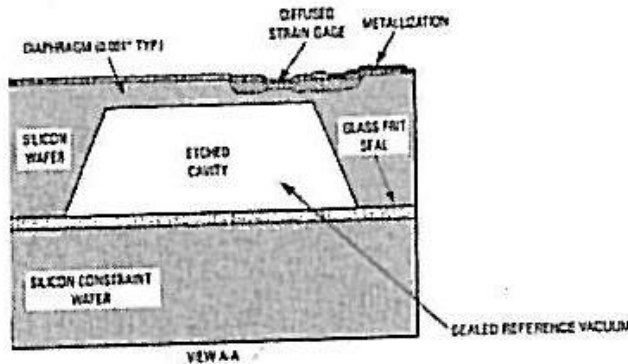


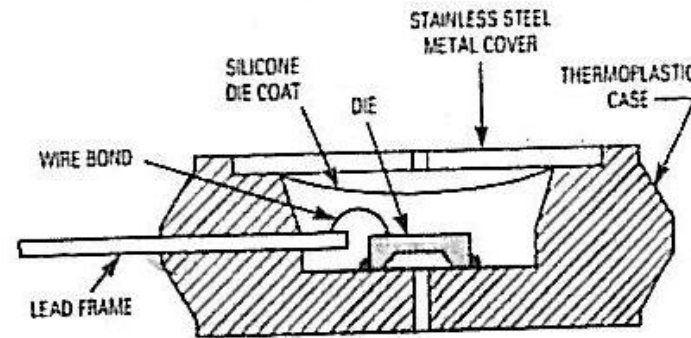
Fig. 10.4. Position of piezoresistors on a silicon diaphragm.



348 10 Pressure Sensors



(A)

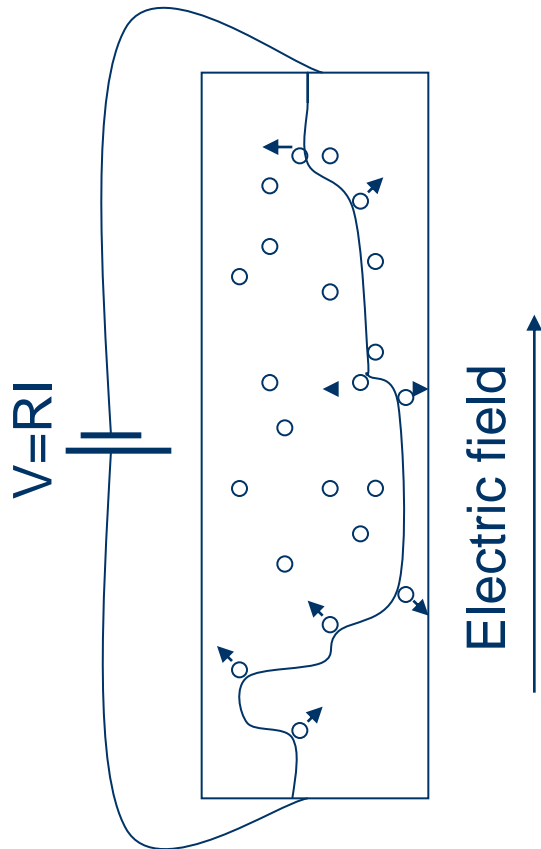


(B)

Fig. 10.7. Absolute (A) and differential (B) pressure sensor packagings. (Copyright Motorola, Inc. Used with permission.)

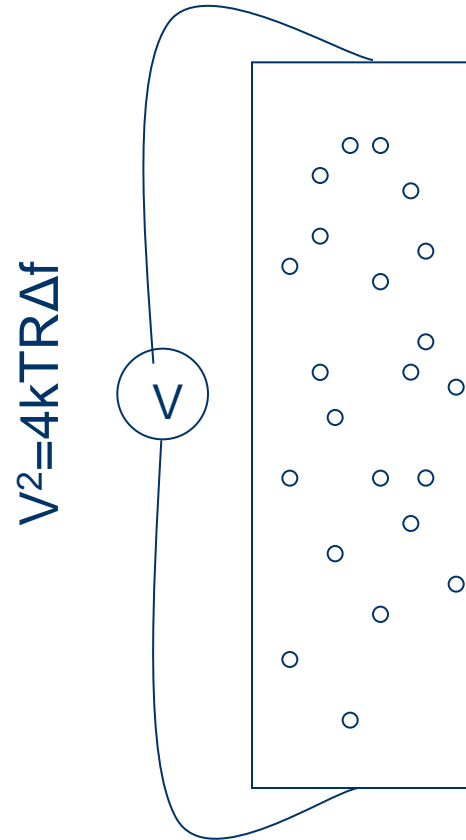
Noise

Resistivity/dissipation:



Electric energy -> Heat

Noise:



Heat -> Electric energy