MANUFACTURE OF STRAIN GAUGES & TRANSDUCERS
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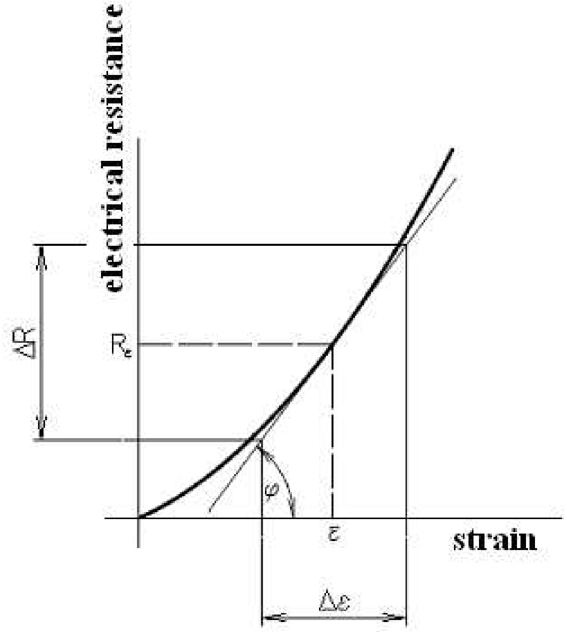
BASIC MATHEMATICAL EQUATIONS



For free gages (without support):

Dependence of resistance to deformation:

$$R_{\varepsilon,25} = R_{0,25} \cdot \left(1 + C_1 \cdot \varepsilon + C_2 \cdot \varepsilon^2\right) \qquad (1)$$

Dependence of resistance to temperature:

$$R_{0,t} = R_{0,25} \cdot \left(1 + a(t-25) + b(t-25)^2\right) \qquad (2)$$

Dependence of resistance to deformation and temperature:

$$R_{\varepsilon,t} = R_{0,t} + R_{0,25}\left[C_1(\varepsilon + (\alpha_{mat} - \alpha_{Si})(t-25)) + C_2(\varepsilon + (\alpha_{mat} - \alpha_{Si})(t-25))^2\right] \qquad (3)$$

The coefficient of strain sensitivity at 25°C:

$$K_{\varepsilon,25} = C_1 + 2C_2 \cdot \varepsilon = \frac{\Delta R}{\Delta \varepsilon} \qquad (4)$$

Dependence of coefficient of strain sensitivity to temperature:

$$K_{0,t} = C_1 \cdot \left(1 + \frac{B}{100} \cdot (t-25)\right) \qquad (5)$$

$$K_{\varepsilon,t} = K_{\varepsilon,25} \cdot \left(1 + \frac{B}{100} \cdot (t-25)\right) \qquad (6)$$

For gages with support:

Dependence of resistance to deformation:

$$R_{B\varepsilon,25} = R_{0,25} \cdot \left(1 + C_1 \cdot \varepsilon + C_2 \cdot \varepsilon^2\right) \tag{7}$$

Dependence of resistance to temperature for free gages does not state because semiconductor element is already glued on the support. For free semiconductor element applies the same formula as for the free gauge without support.

Dependence of resistance to deformation and temperature:

$$R_{\varepsilon,t} = R_{0,t} + R_{B0,25}\left[C_1\left(\varepsilon + \left(\alpha_{mat} - \alpha_{Si}\right)(t-25)\right) + C_2\left(\varepsilon + \left(\alpha_{mat} - \alpha_{Si}\right)(t-25)\right)^2\right] \tag{8}$$

The coefficient of strain sensitivity at 25°C:

$$\mathrm{K}_{\varepsilon,25} = \mathrm{C}_1 + 2\mathrm{C}_2 \cdot \varepsilon = \frac{\Delta \mathrm{R}}{\Delta \varepsilon} \tag{9}$$

Dependence of coefficient of strain sensitivity to temperature:

$$\mathrm{K}_{0,t} = \mathrm{C}_1 \cdot \left(1 + \frac{\mathrm{B}}{100} \cdot (\mathrm{t} - 25)\right) \tag{10}$$

$$\mathrm{K}_{\varepsilon,t} = \mathrm{K}_{\varepsilon,25} \cdot \left(1 + \frac{\mathrm{B}}{100} \cdot (\mathrm{t} - 25)\right) \tag{11}$$

$R_{0,25}$ ….Electrical resistance of the free gauge (without support) at 25°C [Ω]
$R_{B0,25}$…Electrical resistance of the free gauge glued on the support at 25°C [Ω]
$R_{\varepsilon,25.}$….Electrical resistance of the deformed free gauge at 25°C [Ω]
$R_{B\varepsilon,25}$…Electrical resistance of the deformed gauge glued on the support at 25°C [Ω]
$K_{\varepsilon,25}$ ….The coefficient of strain sensitivity at 25°C
$K_{\varepsilon,t}$ ...…The coefficient of strain sensitivity at temperature t and deformation ε
C_1....…Linear coefficient of deformation rate equation *)
C_2....…Quadratic coefficient of deformation rate equation *)
a,b ...…Temperature coefficients of resistance free strain gauges
B .....…Temperature coefficient of strain sensitivity specified by the manufacturer [%/°C]
ε ......…Strain [m/m]
t.......…Temperature [°C]
α_{mat} .….Coefficient of thermal expansion material in which the strain gauge glued [1/°C]
α_{Si} ...…Coefficient of thermal expansion of silicon - 2.8×10^{-6} [1/°C]

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*) Constants C1, C2 are derived from changes in resistance strain gauges glued Cyanoacrylate glue. Epoxy glue hardened above 100°C transferred to the deformation strain gauge with higher efficiency. This increases C1 average value of 5% and the value of C2 average of 50%. The exact values are determined experimentally.