RESISTANCE STRAIN GAGES

Carbon granules, packed in a small volume in the shape of a button and connected in series with a voltage source and a load resistor, have been used in the past as microphones. Using this transduction mechanism, carbon-strip strain gages were developed in the early 1930s. These were, in turn, followed by unbonded and bonded wire strain gages, foil strain gages, and semiconductor strain gages.

Wire strain gages. The resistance of a metallic wire is a function of the material.

$$R = \rho \frac{L}{A} \tag{5.4}$$

When the wire is stretched, its length increases by $\_L$, its diameter decreases by $\_d$, and its resistance increases by $\_R$, assuming that the resistivity remains constant. Substituting these variations in Eq. 5.4 and neglecting higher-order terms, the following expression is obtained:

$$\frac{\Delta R}{R} = \frac{(1 + 2\mu)\Delta L}{L} \tag{5.5}$$

where μ is Poisson's ratio, i.e., the ratio of transverse strain to the axial strain. The strain sensitivity is defined as

$$\frac{\Delta R/R}{\Delta L/L} = 1 + 2\mu \tag{5.6}$$

In unbonded strain gages, as the name implies, the resistance wire is strung between insulated posts. One post is attached to a fixed frame and the other to a frame constrained to move in a fixed direction. Movements that place the wire in tension are measured by the corresponding changes in resistance. This arrangement finds use in certain force and acceleration transducers.

In bonded strain gages, a meandering grid of fine resistance wire is sandwiched between two thin layers of paper and is then impregnated with a resin to provide the necessary strength. The gage is then bonded to the structural members for the determination of the strain at the desired location. The strain sensitivity of an "encapsulated and bonded" gage is defined by the gage factor.

$$GF = \frac{\Delta R/R}{\Delta L/L} \qquad (5.7)$$

where ΔR=resistance change, Ω
R=initial resistance of the gage, Ω
ΔL=change in length, mm
L=initial length of grid, mm

Wire strain gages are rapidly being replaced by foil strain gages, which can be mass-produced using standard photolithographic techniques.

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