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# THE ADVANCEMENT OF SEMICONDUCTOR STRAIN GAUGES.

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**Abstract.** The use of semiconductor strain gauges necessitates the adjustment of resistance variations caused by temperature changes. These variations manifest as apparent strain at the output of the strain gauge.

**Keywords:** E represents Young's modulus, $\gamma$ represents Poisson's ratio, and $\pi_i$ represents the longitudinal coefficient of piezoelectric sensitivity.

The technique of utilizing attached resistance strain gauges (1) for experimental determination and measurement of mechanical stresses is extensively employed in engineering practice.

When a wire or plate with a length of $l_0$ and resistance of $R$ is attached to the part being tested and deformed, such as through tensile force, the length will change to $l = l_0 + \Delta l$, the cross-section will change to S - ΔS, and the resistance will increase to $R = R\_0 + \Delta R$.

The strain coefficient is determined by the dimensionless number obtained by dividing the change in wire resistance by its original value and then dividing it by the relative strain. The equation (1) defines $K$ as the ratio of the relative change in resistance $(\Delta R/R_0)$ to the relative change in length $(\Delta l/l_0)$, which is equal to $\Delta R/(R_0 E)$, where $E$ represents the relative deformation.

$$K = \frac{\Delta R/R_0}{\Delta l/l_0} = \frac{\Delta R}{R_0 E} \qquad (1)$$

The alteration in electrical resistivity caused by unilateral deformation, either stretching or compression, is referred to as the strain-resistive effect. Metals have a little resistance to strain, with a strain-sensitivity coefficient typically falling within the range of 2-3. In contrast, semiconductors demonstrate a far greater sensitivity to strain. This phenomenon can be attributed to the intricate arrangement of energy bands. Semiconductors exhibit a significant strain-resistive impact due to the rearrangement of isoenergetic surface minima positions during deformation and the anisotropy of mobility.

The strain-resistance effect arises from the unique characteristics of the crystal structure and the electrical processes within it. Presently, films made of polycrystalline semiconductor materials are extensively employed as strain gauges. The strain gauge coefficient for monocrystalline samples is determined using a specific formula. [1]

The equation (2) can be expressed as, where E represents Young's modulus, $\gamma$ represents Poisson's ratio, and $\pi_i$ represents the longitudinal coefficient of piez sensitivity. The primary uses of semiconductor strain gauges include:

$$K = \frac{\Delta R}{R_0 E} = 1 + 2\gamma + \pi_i E \qquad (2)$$

1) Used to quantify minuscule distortions;

2) Employed as a highly responsive component in pressure, force, moment, and displacement transducers;

3) Suitable for gauging substantial deformations without the need for costly electronic apparatus.

Compensation of resistance change due to temperature variation is necessary in the use of semiconductor strain gauges. This change in resistance manifests as apparent strain at the output of the strain gauge[2].

An efficient approach is to incorporate the sensor in the "adjacent shoulders of the bridge," meaning that the sensor is placed in the same thermal conditions as the active one, but is not affected by deformation. Dynamic strains can be easily monitored using a potentiometric circuit. To prevent constant signals, such as apparent strain and temperature zero drift, from passing through, a capacitive filter is placed on the output. The user's text is enclosed in tags[3].

Lead salts exhibit significant resistivity due to their relatively substantial piezoelectric effects. $PbS$, $PbSe$, and $PbTe$ offer potential for utilizing these substances in mechanical stress measurements. The transverse piezoresistance value in $PbTe$ is particularly noteworthy. In p-type samples, the value of $\pi_{44}$ is $1.85 * \frac{10^{-10} m^2}{H}$, while in n-type samples it is $1.07 * \frac{10^{-10} m^2}{H}$. PbTe's drawback as a material for a semiconductor strain gauge lies in its limited mechanical strength. The high sensitivity to strain exhibited by pressed $PbS$ samples enables their use as strain gauges for measuring strain. In order to quantify the degree of deformation caused by bending, $PbS$ samples were affixed to a steel substrate using adhesive. The strain-sensitivity coefficient of the PbS strain gauge is significantly higher than that of wire strain gauges, ranging from two to three orders of magnitude. The strain-sensitivity coefficient is enhanced through heat treatment, which is similar to the process used to produce sensitive $PbS$ photo-resistances. This treatment is believed to result in the creation of p-n junctions on the grain boundaries, generating a layer that is sensitive to light. The variation in barrier height during deformation appears to be the underlying factor contributing to the significant strain impact observed in compressed PbS particles. The strain-sensitivity coefficient was significantly increased to values in the order of several thousand with the use of heat treatment.

## Literature:

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