*Journal of Engineering Physics and Thermophysics, Vol. 75, No. 6, 2002*

# PRESSURE TRANSDUCER BASED ON TENSOSENSITIVE FILMS OF BISMUTH–ANTIMONY TELLURIDE

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UDC 621.362.1

*A new design of a semiconductor pressure transducer based on tensosensitive films of bismuth–antimony telluride, which provides a temperature compensation for the entire device structure, is proposed. The technical data of the tensometric transducer proposed for measuring the pressure of liquids and gases are presented.*

It is well known that the sensitivity of a resistance strain gauge in diaphragm transducers depends on the topology of its arrangement and the length of the active part. In the case of radial arrangement, the parts located at the geometric center of the diaphragm or at its periphery have the highest sensitivity. However, in this case, the edges of the bases of the resistance strain gauges undergo a significant alternating deformation; because of this, engineers designing devices run into great difficulties with the contacts to the resistors because of their extraordinary complexity.

Another problem arises when the current leads of the ends of a resistance strain gauge are installed. The existing technologies of soldering, bonding, or resistance welding of current-leading wires to the contact lands of electronic devices have advantages only in the case where mechanical stresses are absent. In systems with an intense alternating deformation, the regions of attachment of wires tire rapidly and the effects of cracking and flaking arise, which causes irreversible parasitic changes in the properties of the device structures. In the case where there are deformations, the pressure contacts used also have a negative effect on the characteristics of tensoresistive devices, since under deformation the region where the contact touches the contact land slips because of the variability of the geometric dimensions of the diaphragm; moreover, the landed force changes.

We have developed a fairly simple method of eliminating undesirable effects arising as a result of the output of a desired signal to the recording system. Figures 1 and 2 show the diagrammatic representations of the diaphragms of a semiconductor pressure transducer, which have been obtained by thermal-vacuum evaporation of a semiconductor material of bismuth–antimony telluride [1]. In Fig. 1, the arrangement of the resistance strain gauge is shown. The design of the diaphragm is such that the thickness of its periphery is much larger than the active (deformable) region. The radial resistance strain gauge is applied in such a manner that its ends are brought to the periphery (almost undeformable) part of the diaphragms. The contact lands to the resistance strain gauge are made on this nondeformable part of the diaphragm. Such a design of the sensitive element of a semiconductor pressure transducer makes it possible to use any current-leading system: bonded, soldered, or pressure contacts. Their properties depend only slightly on the deformation of the sensitive part of the diaphragm in comparison with the change in the tensosensitive characteristics proper of the film.

The above-described design of the semiconductor pressure transducer makes it possible to provide, in a unified technological regime of synthesis of a tensoresistive film, temperature compensation for the entire device structure. This is very important in actual tensoresistive structures, since the temperature of the environment and the heating of the transducer by the measuring current from the power source introduce a significant error into the measurement of mechanical stresses with the use of semiconductor resistance strain gauges.

We used a passive circuit of temperature compensation. In this circuit, the bridge arm is a film obtained simultaneously with the resistance strain gauge on the undeformable part of the diaphragm (see Fig. 1). Since the temperature compensator and the resistance strain gauge are synthesized at a time, their parameters are identical, which

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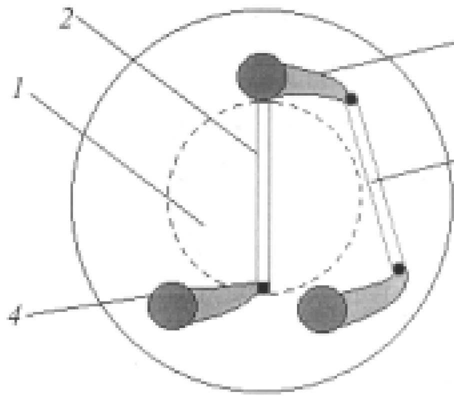


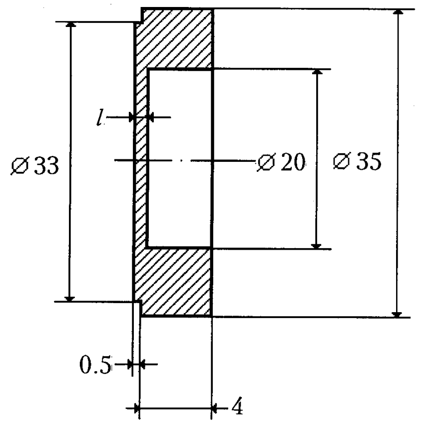


| $l$, mm | 0.25 | 0.35 | 0.8 | 1.5 |
|---|---|---|---|---|
| $P$, atm | 0 -10 | 0 -25 | 0 -100 | 0 -150 |

Fig. 1. Diagrammatic representation of the arrangement of bismuth–antimony telluride films on the diaphragm of the pressure transducer: 1) diaphragm; 2) $Bi_2$–Sb–$Te_3$ films; 3) contact lands; 4) contact with the current-leading wires.

Fig. 2. Representation of the diaphragm of the semiconductor pressure

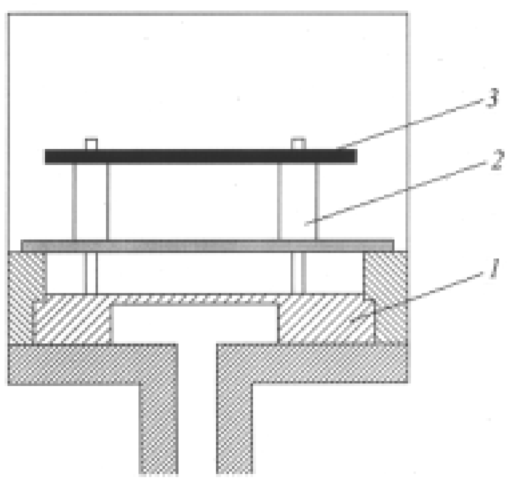


Fig. 3. General view of the semiconductor pressure transducer: 1) diaphragm; 2) probes; 3) plate with adjusting resistors and an amplifier.

significantly simplifies the matching of the measuring bridge circuit. The contact lands to the resistance strain gauge and the temperature compensator are also made in a unified technological regime.

The natural investigations of the operating characteristics of semiconductor pressure transducers have shown that the thickness of the active (deformable) part of the diaphragm $l$ must be selected in every case with regard for the maximum pressure that can exist in the system. The values of $l$ recommended for pressure transducers operating in various ranges are given in Fig. 2.

Figure 3 shows the design of the pressure transducer in which the current-leading wires are probes pressed against the contact lands. To reduce the weight of the device and provide a satisfactory seal, we recommend using products of structural alloys, in particular, of Duralumin, as the accessories. The adjusting resistors and the amplifier are assembled in the frame of the pressure transducer on a special plate fastened to the probes.

The technical data of the semiconductor tensometric transducer for measuring the pressure of liquids and gases are as follows:

| | |
|---|---|
| Weight | no more than 1 kg |
| Dimensions | no more than $60 \times 60 \times 120$ mm overall |
| Range of measured pressures | 1–150 atm |
| Measurement error | no more than 1% |
| Working voltage | 220 V and 15 V |
| Power consumption | no more than 6 W |
| Information generated | digital, analog, and code |
| Operation temperature | (–25)–(+100)$^{o}$C |
| Relative humidity | 80% |

The tensometric transducer can be used in the off-line regime as well as in automated systems for control of the pressure of liquids and gases.

## REFERENCES

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