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COMPARATIVE EFFICIENCY OF PYROELECTRIC MATERIALS

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The efficiency of technical applications of various mono- and polycrystals, polymers, and films as temperature sensors has been investigated in a wide range of temperatures. The opportunities for using particular materials are shown to depend on the climatic conditions for which the sensors are intended.

One of the pressing problems in contemporary electronics is extension of its circuitry, especially, with the use of multifunctional solid-state components. At present much attention is paid to sensor devices for environmental monitoring, particularly, for analysis of the surrounding of industrial objects consuming or using a considerable amount of energy. Apparently, pyroelectric transducers, used in nonselective receivers of radiation, are promising in this field. They may be applied in infrared sensors, measurers of microwave power, and in other devices for conversion of thermal into electric energy.

The advantage of pyroelectric sensors consists in their low noise level and ability to measure the environmental temperature without special cooling. Such cooling has to be introduced in the case of semiconductor sensors of infrared radiation, because narrow-gap semiconductors are used in them. Moreover, semiconductor sensors use the effect of temperature-dependent photoconductivity, which is never free from the noise produced by scattering of electrons on the crystal lattice oscillations. In contrast to this, in pyroelectric sensors we use the effect of temperature variation of spontaneous polarization in dielectric crystals whose conductivity is almost lacking. Therefore, they have no noise due to electron scattering, which is another of their advantages.

The diversity of technical applications of pyroelectric transducers demands a certain combination of electric, thermal, and mechanical properties of the kernel pyroelectric bodies. So, despite a large number of known polar mono- and polycrystals exhibiting pyroelectric properties, only a few of them are of real utility.

Solid pyroelectric specimens. The prospects for pyroelectrics application can be evaluated with the aid of some quality parameters representing a definite combination of electric and thermal properties of pyroelectric materials. However, in the literature on pyroelectrics one can hardly find any comparison of their applicability in different climatic conditions — particularly, their thermal stability has never been evaluated. At the same time, this parameter is of primary importance, since the pyrosensors need no special cooling or temperature stabilization.

In this work the pyroelectrics are compared in efficiency and thermal stability of their conversion characteristics. Based on the tests performed and some literary sources, we calculated the quality parameter of pyroelectric materials defining the current (ampere-watt) sensitivity S_i, and another parameter characterizing the sensitivity of pyroelectric elements to voltage (volt-watt response).

The analytical expression for the current sensitivity of a pyroelement, with an accuracy sufficient for practical applications, can be written in the form

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