ENERGY CONVERTER BASED ON NANO-STRUCTURED SI

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https://doi.org/10.5281/zenodo.8016384

Abstract: Nowadays, polycrystalline silicon is used as a cheap raw material in many fields, in particular, in photo energy and microelectronics. Cheap and radiation-resistant solar cells based on them are used. In addition, in the preparation of semiconductor devices, the physical properties that are manifested under certain conditions are unique to polycrystalline silicon and are related to its structure, which increases the interest in such materials.

Key words: Semiconductor, polycrystalline silicon, granule, sunlight, thermoelectric materials, solar oven, electrical conductivity, ceramic material.

Enter

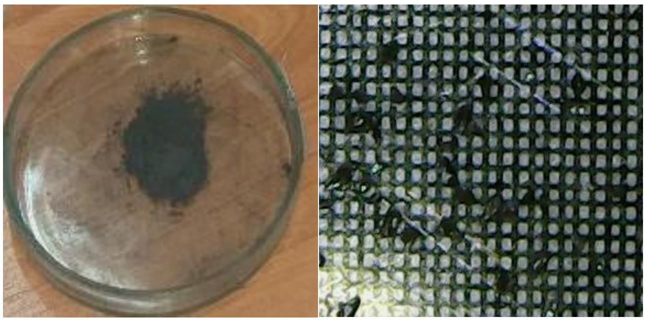
There are many methods for the preparation of semiconductor thermoelectric materials, and now the powder technology, which is widespread and highly efficient, is of great importance. Due to its simplicity, reliability, and the fact that it does not require complex operations, powder technology is widely used in metallurgy for obtaining various plates, processing the surfaces of materials, and other purposes. However, due to the fact that the preparation of powders is carried out by mechanical methods, intrusions from the external environment lead to the formation of various defects in the volume or surfaces of the material [1-9]. These disadvantages degrade the quality of the final product and are extremely unsuitable for electronic clean semiconductor materials. In connection with these, studying the methods of obtaining polycrystalline silicon plates intended for obtaining thermoelectric material using powder technology is one of the most pressing problems today[1-12].

Research method

Production of prolicrystalline silicon wafers based on this technology can be done in two ways. In the first method, prolicrystalline silicon flakes or waste from monocrystalline production are used. n and p-type monocrystalline silicon and prolicrystalline silicon pieces with ρ~1÷10 Ohm cm, n~10^{15} cm^{-3} are used as raw materials. After the pieces are crushed to a size of 1÷2 mm, the surface of the silicon particles is covered with a layer of nano-sized Si dioxide in a special mill, it is reduced to a powder size of up to 1 micrometer, and it is measured under a microscope (1 - picture).

(Fig. 1. Micrometer)

This method is simple, initially dried powders are passed through a magnetic field. Constant or alternating electromagnetic fields can be used as a source of magnetic field. These powders are determined by the degree of contamination. When grinding pieces of raw materials, it is desirable to take into account the magnetic properties of the input introduced by the external environment and the degree of formation of compounds with semiconductor materials [2-6]. In this work, a durable deformation-resistant ceramic material with a smooth hemispherical surface and a ceramic hammer were used to grind silicon. Since the process is carried out at room temperature, there is no chemical reaction between silicon and the input atoms entering from the external environment. The method of cleaning powders does not require additional energy. For this, filter paper is placed on the surface of the magnet at an angle of 80÷95 degrees. The granules fall on the surface of the filter paper in the required amount. During the friction of the granules with the filter paper, the entrances with magnetic properties remain on the surface of the paper. As a result, a layer of pores is formed on the surface of the filter paper. A mixture is prepared by adding ethyl alcohol to the powders consisting of the prepared granules. When the mixture is heated between T-700^{o} C and T-1200^{o} C using a solar furnace, strong tunnel contacts are formed in the two adjacent areas of the granules as a result of partial bonding. layer is formed [4,10-11]. In the forbidden zone of the nanolayer formed between the granules attached by the heating method, local energy levels satisfying the following relationship are created and resonant tunneling of electrons is ensured [4].



(Fig. 2. Si granules with a size of 1 μm)

Analysis and results

The dimensions of the obtained thermoelectric materials consisting of plates and thin layers of different sizes are of great importance, and depending on these, there are various methods of determining the thermal conductivity and specific resistance of samples of different geometric shapes [12-14].

To study the influence of temperature-dependent state and electrical properties of thermoelectric material, sample ρ, μ, and n, determination of the energy distribution of localized levels (traps) in thermoelectric material (that is, density of states) and to explain the obtained results. thermoelectron emission models were used [20-24].

ρ of the samples was studied using special Van der Pauw methods based on the Hall effect. The relative resistance was calculated using the following formula:

$$\rho = 4{,}53 \cdot \frac{U \cdot d}{I} \qquad (1)$$

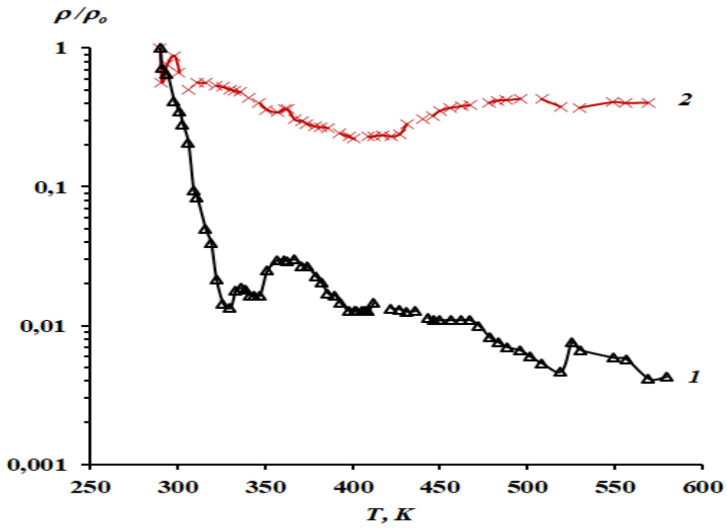
here; U - potential difference, I - working current, d - sample thickness.

In this case, the Hall constant was determined as follows:

$$R_X = 10^8 \frac{U \cdot d}{I \cdot H} \qquad (2)$$

here; H - magnetic field strength

The electrophysical parameters of the samples were studied in the range of 300÷800 K. The obtained results were analyzed using the thermoelectron emission model.



(Fig. 2. Dependence of resistance on temperature)

Localized deep or shallow surface traps in solar reheated thermoelectric materials create a barrier effect. In polycrystalline semiconductors, localized traps in the grain boundary area create a barrier effect. Also, ρ depends on the change of the potential barrier height (φ) during the capture and release of charge carriers in localized traps [7-16].

In short, using semiconductors and semiconductor materials as raw materials, a semiconductor thermoelectric material was obtained. It was found that the obtained material is cheaper and more durable than similar sample materials.

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