3. Technology of production of high effective thermoelectric materials on the base of nanodimensional films of $CoSb_3$ skutterudite

Short description of technology: Nanodimensional $CoSb_3/SiO_2$(100 nm)/Si(001) film compositions of nanometer (10 – 50 nm) thickness will be obtained by co-deposition of Co and Sb in vacuum of 10^{-9} Pa on substrates of monocrystalline Si(001) covered SiO_2 layer at room temperature or heated to temperature in the range (370 – 570)K. Sb deposition will be carried out by effuser and Co – by electron-beam methods. For alloying of film it will be used Ba, Yb, Tl, Ce, La. For thermal treatment it will be applied annealing in nitrogen or vacuum in temperature range of (570 - 970)K.

Novelty: Thermoelectrics is priority direction of development of science and technique based on the direct conversion of thermal energy into electric. Absence of moving parts and possibility of functioning in extreme conditions provide a high reliability and practically unlimited resource of work to the thermoelectric energy sources. The special advantage is using the thermal energy that is lost. For this reason such sources are founded wide application in space, in a military technique and in the way of life. The conversion efficiency is determined by dimensionless figure of merit

$$ZT=S^2 \sigma T/(k_e+ k_l),$$

where σ *is thermal conductivity,* S *is Seebeck coefficient,* T *is temperature,* k_e *is the carrier thermal conductivity,* k_l *is the lattice thermal conductivity).*

In spite of active attempts to get material with the high value of ZT nowaday thermoelectric elements which in majorities are synthesized by the methods of powder metallurgy have ZT which does not exceed 1. In the nanodimensional film state ZT, as theoretical calculations show, can have value ≥ 2. It is explained that at transition to nanodimensions the electron-phonon interaction decreases and a phonon subsystem, being adiabatically isolated, does not almost accept participating in the transfer of heat from a heater to the cooler. Therefore nanostructuring of thermoelectric materials is

effective technology to achieve a high ***ZT*** due to achievement of low thermal conductivity.

It is suggested to use the nanodimensional $CoSb_3$ –based skutterudite film as thermoelectric material with high-performance thermoelectric properties. A lattice thermal conductivity can be considerably reduced due to decrease of size of grains that results in additional scattering of phonons on the grain boundaries, and also presence of pores in films. One of the special properties of skutterudite compounds there is also possibility of decrease of lattice thermal conductivity when small in size atoms fill pores in the crystalline structure of skutterudite. Alloying atoms (filler of pores), for example, the atoms of elements of Ba, Yb, Tl, Ce, La, at resonance frequency additionally scatter heat, what is carried by phonons, that results in the lower thermal conductivity of film. Due to it thermoelectric efficiency of ***ZT*** can attain the value more than 1,4.