STUDY OF SEMICONDUCTING THERMOELECTRIC MATERIAL $Er_{1-x}Zr_xNiSb$

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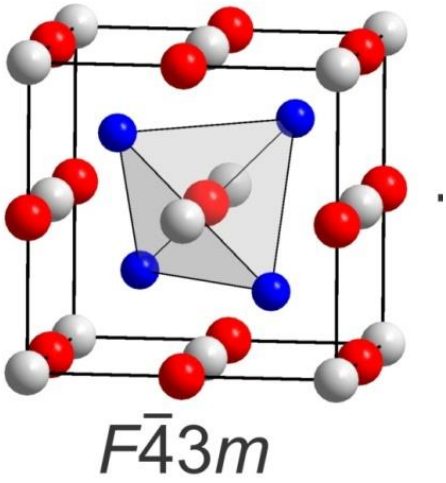
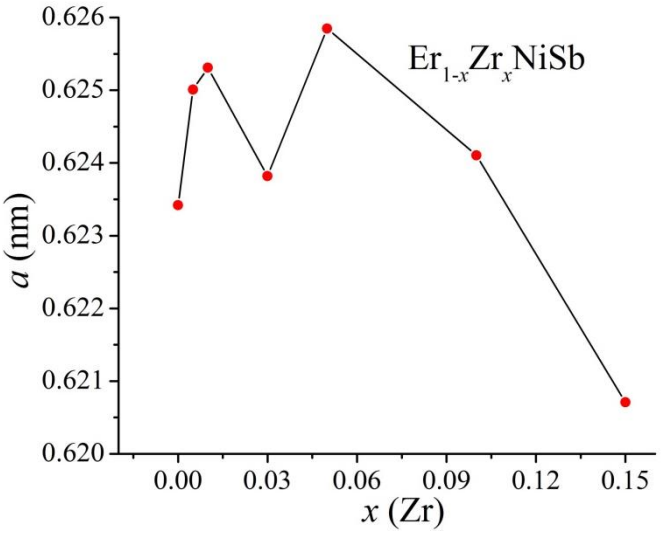
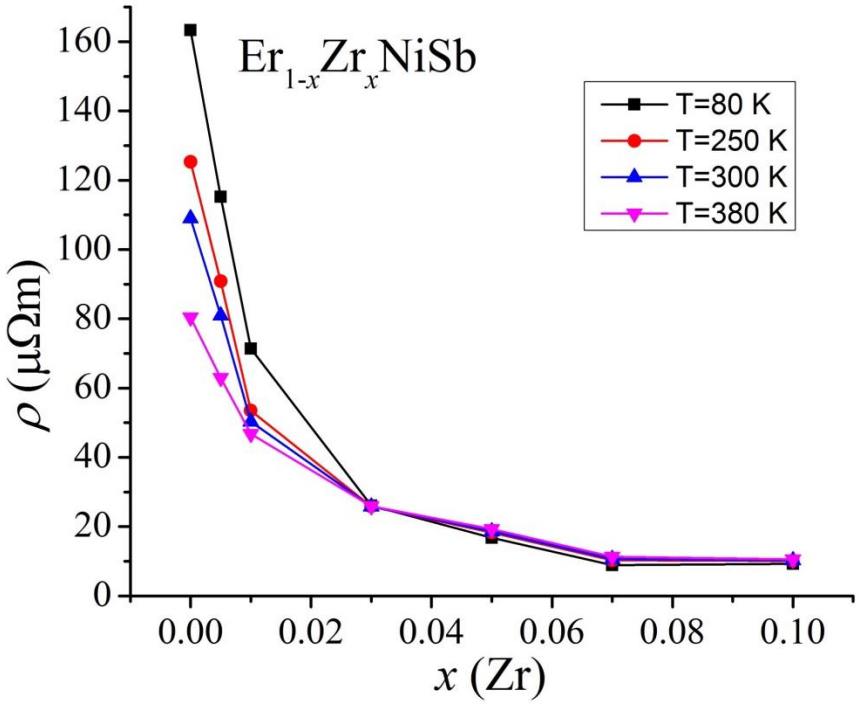
RNiSb compounds (R-rare earth metal) and corresponding solid solutions with the MgAgAs structure type (space group $F\bar{4}3m$) are semiconductors and promising thermoelectric materials.

The structural, kinetic, energy state and magnetic characteristics of the $Er_{1-x}Zr_xNiSb$ (x=0–0.10) solid solution were investigated. Structural studies of $Er_{1-x}Zr_xNiSb$ showed that impurity Zr atoms can partially occupy different crystallographic positions in the ErNiSb structure and generate the structural defects of the different nature.

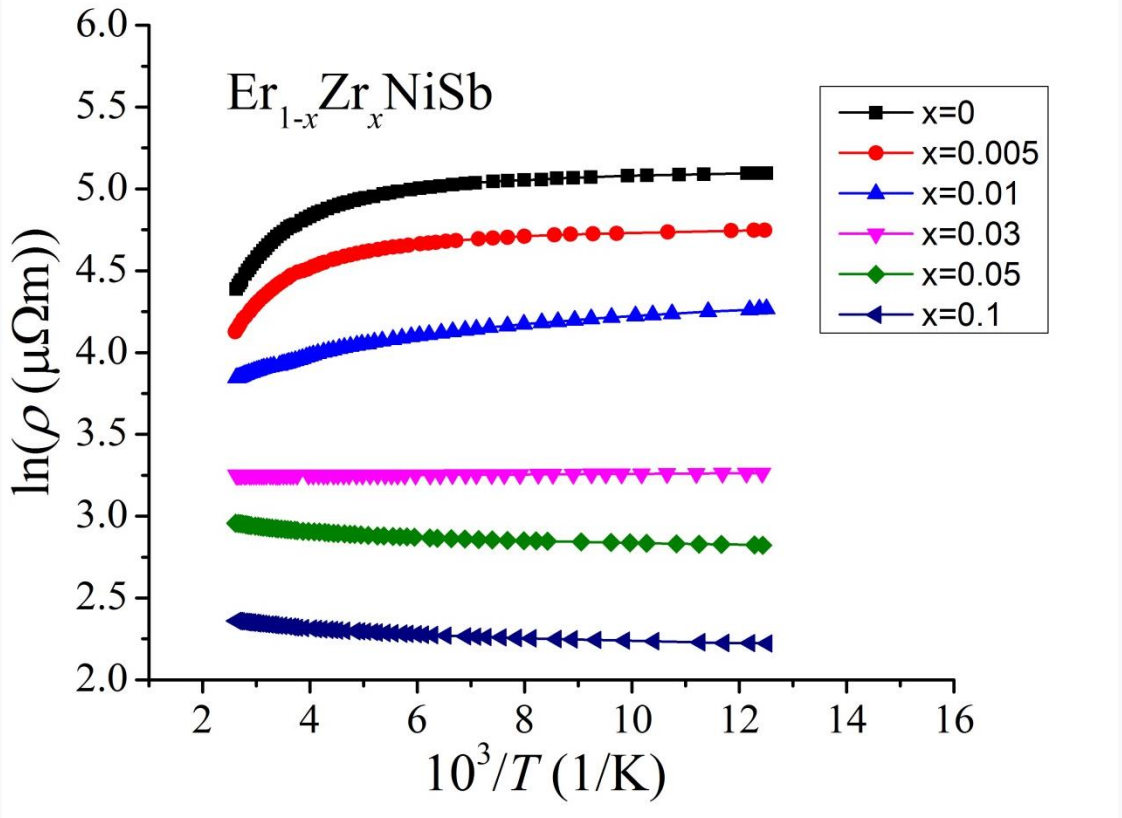




Temperature dependencies of electric resistivity $\ln(\rho(1/T))$ and thermopower coefficient $\alpha(1/T)$ of $Er_{1-x}Zr_xNiSb$, x=0÷0.03, are typical for compensated semiconductors with activation parts which indicates the location of the Fermi level ε_F in the band gap. Positive sign of the thermopower coefficient $\alpha(T,x)$ of the ErNiSb compound showed the hole-type of the conductivity and location of the Fermi level near the valence band at a distance ε_1^{ρ}=45.2 meV. Introduction in the ErNiSb compound the lowest concentration of the Zr atoms (x=0.005) does not change the thermopower coefficient sign, results in a decreasing of the resistivity values and depth of the the Fermi level up to ε_1^{ρ}=39.8 meV. For a *p*-type semiconductor, this is possible when the concentration of acceptors increases and the concentration of free holes become higher. Thus, at x=0.005 Zr atoms do not occupy 4*a* position of the Er atoms and the donors are not generated.

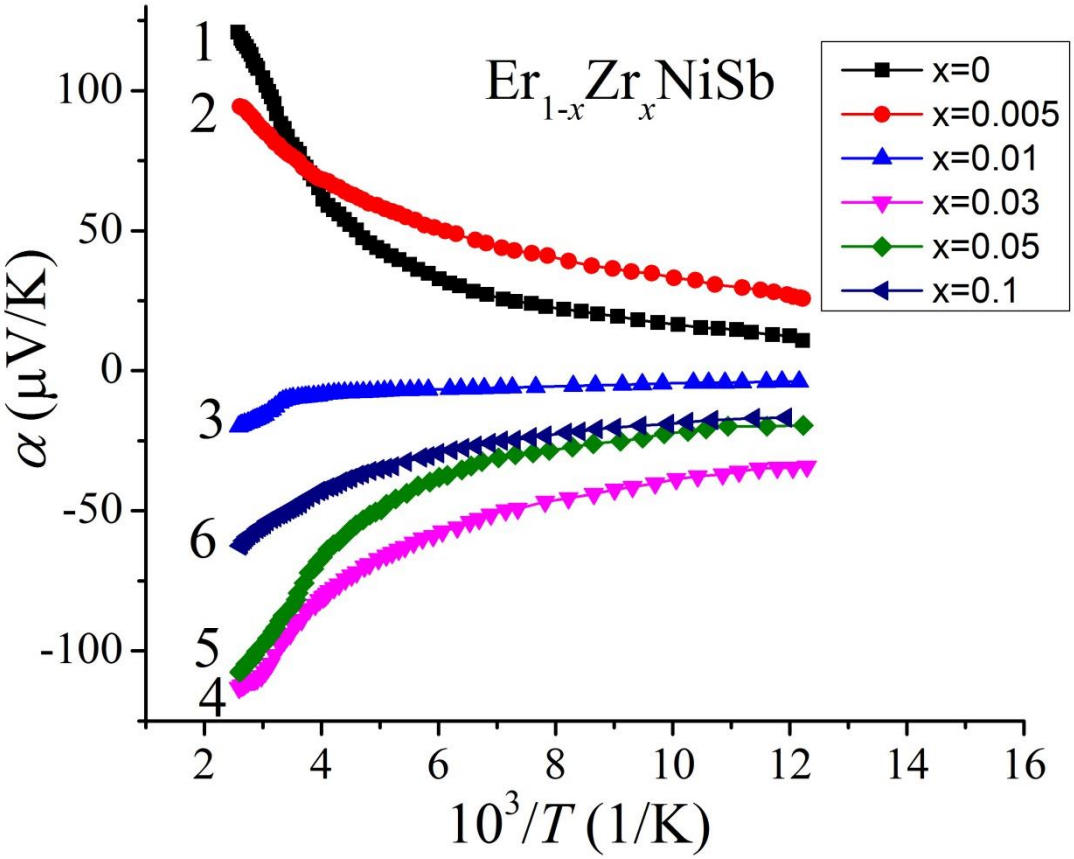


Variation of electric resistivity values with Zr content in the $Er_{1-x}Zr_xNiSb$ solid solution



Temperature dependence of the electric resistivity for $Er_{1-x}Zr_xNiSb$ solid solution

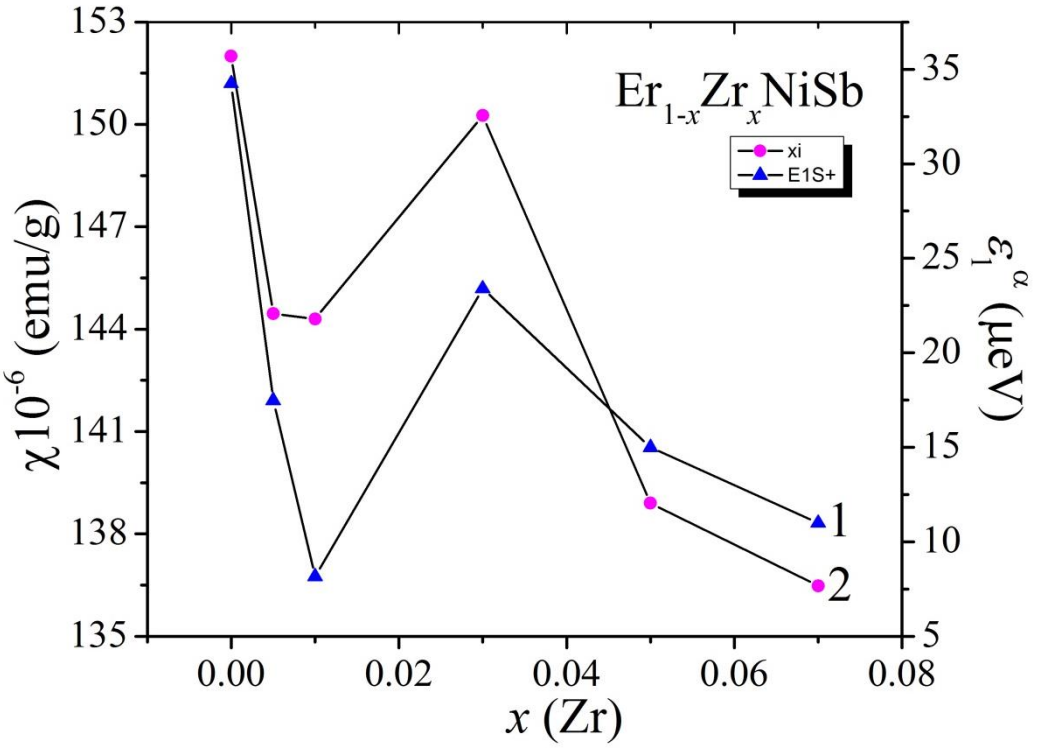
At x=0.01 the sign of the thermopower coefficient $\alpha(T,x)$ of $Er_{1-x}Zr_xNiSb$ is negative at all temperatures and electrons are the main charge carriers. At x=0.01 the Fermi level lies near the conduction band at a distance 6.7 meV. At higher Zr content (0.01<x) the sign of the thermopower coefficient $\alpha(T,x)$ remains negative at all temperatures and activation parts on $\ln(\rho(1/T))$ dependencies disappear through metallization of the conductivity.



Temperature dependence of the thermopower coefficient for $Er_{1-x}Zr_xNiSb$ solid solution

Magnetic susceptibility measurements $\chi(x)$ of $Er_{1-x}Zr_xNiSb$ at 300 K confirmed the simultaneous generation of the structural defects of the acceptor and donor nature. $Er_{1-x}Zr_xNiSb$ samples are Pauli paramagnets, their magnetic susceptibility is determined by free electrons and

proportional to the electron density at the Fermi level $g(\varepsilon_F)$. There is a complete correlation in the behavior of $\chi(x)$ and $g(\varepsilon_F)$ for $Er_{1-x}Zr_xNiSb$.



Magnetic susceptibility (2) and activation energy vs Zr content for $Er_{1-x}Zr_xNiSb$ solid solution