# ELECTROPHYSICAL AND THERMAL PROPERTIES COUNTERVAILED SOLID SOLUTIONS $ND_XSN_{1-X}SE$

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## ABSTRACT

Agency of neodymium on electrophysical properties of solid solutions $S_{n1-x}N_{dx}Se$ ($0{,}0 \le x \le 2{,}0$) is explored. It is erected, that depending on a content of neodymium there is an inverse to a sign reversal of conductivity. At small contents of neodymium (Nd) there is the strong scattering charge carriers from a phonon current that result ins to a diminution of a common thermal conduction and carrier mobility. With magnification of content Nd the thermal conduction improves and partially increases carrier mobility. It is revealed, that the explored exemplars are partially compensated semiconductors with the blended type of conductivity.

**Keywords:** neodymium, conduction, magnification, thermal, semiconductors.

## I. INTRODUCTION

Many semiconducting solid solutions on the basis of junctions $A^{IV}$ $B^{IV}$ explicitly are explored and have found application at making various transformings an energy [1,2]. In last years solid solutions on the basis of junctions $A^{IV}$ $B^{IV}$ with involvement of rare-earth metals, including $S_{n1-x}N_{dx}Se$ are intensively studied. Concern to these substances in the core is called by that, on the one hand, SnSe is a thermoelectric substance with vacancies in both sublattices which one interacting result ins to formation of antistructural imperfections, on the other hand, neodymium (Nd) has original electronic pattern of atoms and very strongly influences physical properties [3,4]. Specially concern to these semiconductors is justified by a possibility of control of concentration of the free current carriers in a wide spacing ($10^{16} \div 10^{19}$) $sm^{-3}$ by a modification of concentration of neodymium in solid solutions $S_{n1-x}N_{dx}Se$ without an essential modification of their pattern.

## II. EXPERIMENTAL TECHNIQUE

Exemplars gained from a direct alloying of source reductants in degasified quartz vessels. As source components brands of especially pure substances served.

In the present operation alloys of compositions with x = 0,0 are explored; 0,05; 0,1; 0,25; 0,50; 0,75; 1,00 and 2,00. The explored exemplars had p and n types of conductivity exemplars. The exemplars 2,0 x 5,0 x 2,0 $мм^3$ were carved by sizes from bullions on high-tension adjustment. Thermoelectromotive ($\alpha$) and thermoconductivity ($\chi$) were metered by a terrain clearance stationary method under the method of application presented in [3]. An electrical conductivity ($\sigma$) and Hall coefficient (Rx) metered at a direct current on a constant electromagnet. Temperature instituted by means of copper-constantan of the thermoelectric couple. The Measuring error of a thermal conduction and Thermoelectromotive Compounded less than 6 %, and an electrical conductivity and Hall coefficient did not exceed 3,2 %.

## III. RESULTS AND DISCUSSION

Constitutional diagram SeSn - Nd is explored in [3].

As dissolubility Nd in SeSn 5,4 % at. follow from a constitutional diagram matches low fidelity % Nd. From field of solid solutions for exploration the above-stated compositions have been selected and electrophysical properties are metered.

Apparently from figure 1, meaning of coefficient Thermoelectromotive. ($\alpha$) and Hall coefficient (Rx) with growth of concentration increases and at x=0,95 at. %. Nd the electrical conductivity changes a sign from p type on n, , smoothly relieves and goes on through a minimum. At x=0,75 meanings x also go on through a maxima ($\alpha$ =651mkV/K, R = 322$см^3$ $\cdot Kl^{-1}$) which one matches to meaning of concentration of carrying agents $p=1{,}94 \cdot 10^{18}$ $sm^{-3}$, that on two orders it is less, than at source SnSe ($p=6{,}4 \cdot 10^{18}$ $sm^{-3}$).

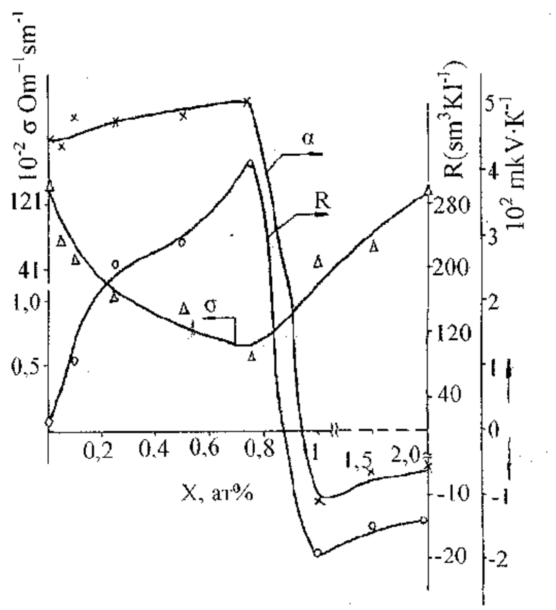


Figure1. Association of arguments on concentration of content Nd in an alloy $S_{n1-x}N_{dx}Se$:
x - thermopower (α);
O - Hall coefficient (R);
Δ- An electrical conductivity (σ).

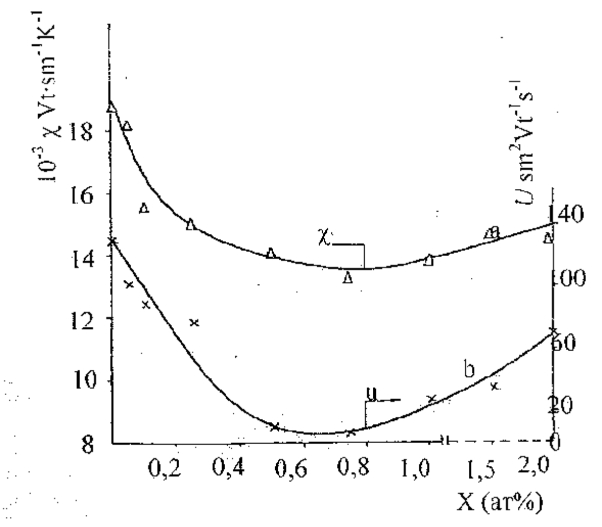


Figure 2. The Concentration dependence:
a - thermal conduction;
b - carrier mobility in alloy $S_{n1-x}N_{dx}Se$, T=300K

Such diminution of concentration of current carriers in explored exemplars produces us the foundation to guess, that at passage from SnSe to solid solutions Sn1-xNdxSe there is a partial compensating of charge carriers.

In figure 2a associations of a thermal conduction $\chi$ and mobility u current carriers from a content of neodymium in explored exemplars are introduced at T=300K.

In figure 2b the modification of arguments of the elemental gratings for exemplars with x=0,0 is demonstrated; 0,25; 0,50 and 1,00. From figure it is visible, that at substitution of atom of stannous by atoms of neodymium arguments of the elemental grating increase, i.e. the gained solid solutions possess is gentle strained orthorhombic structure. And solid-solution formation $S_{n1-x}N_{dx}Se$ at heterovalent substitution, compensating of basicity, in particular, electrical conductivity in a crystal lattice, is carried out as a result of a modification of a charge state, i.e. under an operation of the strong polarization by ions $Nd^{3+}$ in structure SnSe, $Sn^{2+}$ (0,74Å). Thus substitution has group nature, i.e. two ions ($Nd^{3+}$) substitute ions $Sn^{2+}$ and $Sn^{4+}$ [5,6].

From figure 2a it is visible, that the thermal conduction of exemplars with growth of content Nd noticeably relieves (already at small concentrations: x≥0,20

$\Delta\chi = (18{,}7-13{,}4)\cdot 10^{-3}\,\frac{Vt}{sm\cdot K} = 5{,}3\cdot 10^{-3}\,\frac{Vt}{sm\cdot K}$), and then $\chi$ increases up to $15{,}9\cdot 10^{-3}\,\frac{Vt}{sm\cdot K}$ at x=2,0. Such modification of a thermal conduction testifies that, on the one hand, at substitution of atoms of stannous by atoms of neodymium there is a partial recombination of vacancies to current carriers and simultaneously there are complementary scattering center of charge carriers [7] that proves to be true at a modification of a thermal conduction of exemplars.

## IV. CONCLUSIONS

1. At substitution of atoms of stannous by atoms of neodymium in alloys $S_{n1-x}N_{dx}Se$ there is a partial compensating, and the gained exemplars are compensated semiconductors with the blended conductivity.
2. During substitution of atoms of stannous by atoms of neodymium the dodge of conductivity and a thermal conduction due to a diminution of point defects improves.

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