substance: $T_{1-x}T'_x(V)_3$ compounds
property: doping and ternary phases of transition element tripnictides

$Co_{1-x}Fe_xAs_3$: Solubility: x ≤ 0.1 [62R], ≤ 0.16 [62P]. Metallic behavior results already at x = 0.01, although additional substitution increases the resistivity. At x = 0.01 the conduction is p-type and changes to n-type at higher Fe concentrations [62P] (Fig. 2).

$Co_{1-x}Fe_xSb_3$: Solubility: x ≤ 0.25 [59D]. For x = 0.01 an exponential increase of $\sigma(T)$ is observed above 620 K; $E_A \approx 0.07$ eV, assuming $\log \sigma \propto -E_A/kT$ [59D]. Increasing Fe concentrations strongly reduce the resistivity and change the thermopowr from large negative to small positive values [59D].

$Co_{1-x}Ni_xAs_3$: Solubility: x ≤ 0.6 [62R], ≤ 0.65 [62P]. Nickel behaves as a donor impurity. Conduction becomes n-type with 1% substitution of Ni for Co. At x ≈ 0.1 the system becomes metallic [62P] (Fig. 1).

$Co_{1-x}Ni_xSb_3$: Solubility: x ≤ 0.1 [59D]. Ni is adopting a valence of 4 and thus acts as a donor, fully ionized at room temperature. Up to x ≈ 0.01 the electron mobility and the microhardness increase (occasional purity effect ?), then decrease. The thermoelectric power reaches a maximum of - 350 μV K^{-1} at x = 0.025...0.05 [59D]; Table below and Figs. 3, 4, 5 and 6.

Room-temperature values for the electron concentration *n* (from Hall effect), the electron mobility μ_n, the thermal conductivity κ, the microhardness *H* [57D], and the thermoelectric power *S* [59D].

x	*n* [cm^{-3}]	μ_n [cm^2/V s]	κ [W cm^{-1} K^{-1}]	*H* [kg mm^{-2}]	*S* [μV K^{-1}]*)
0	$2.2 \cdot 10^{17}$	290	0.052	370	– 170
0.5	$3.0 \cdot 10^{18}$	610			– 350
1	$2.4 \cdot 10^{18}$	510	0.049	390	– 280
2	$1.3 \cdot 10^{19}$	110	0.048		– 220
4	$1.2 \cdot 10^{20}$	22	0.043	382	– 150
8			0.029	299	

*) Compare Fig. 5.

$Rh_{1-x}Pd_xAs_3$: Solubility: x ≈ 0.07 at 1023 K [66B].

$Ir_{1-x}Pt_xAs_3$: Solubility: x < 0.1 at 1023 K [66B].

Substitutions at constant valence-electron concentration:

$CoP_{3-x}As_x$: Solubility: x = 0...3, Végard's law obeyed [81L]. Far infrared spectra: [81L].

$CoAs_{3-x}Sb_x$: Solubility: x = 0...0.4 and 2.8...3; miscibility gap [81L]. Far infrared spectra: [81L].

$CoSb_{3-x}Bi_x$: Solubility: x ≥ 0.06? [59D]. Small Bi substitutions do not much change the electrical conductivity and the thermopower [59D]. At x = 0.06: $E_{g,th} \approx 0.35$ eV above 500 K, assuming $\log \rho \propto Eg/2kT$ [59D].

$Co_{1-x}Fe_{x/2}Ni_{x/2}As_3$: Solubility: x = 0...1 [62R].

All compositions are expected to be nonmetallic. [62P] did not observe $Fe_{0.5}Ni_{0.5}As_3$: They reported a solubility in $Fe_yNi_{1-y}As_3$ of y = 0.25...0.46. $Fe_{0.46}Ni_{0.54}As_3$ was found to be an n-type semiconductor. With higher nickel concentration the system becomes metallic [62P] (Fig. 2).

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Fig. 1.

$CoAs_3$, $RhAs_3$ and $Co_{1-x}Ni_xAs_3$. Resistivity vs. reciprocal temperature [62P].

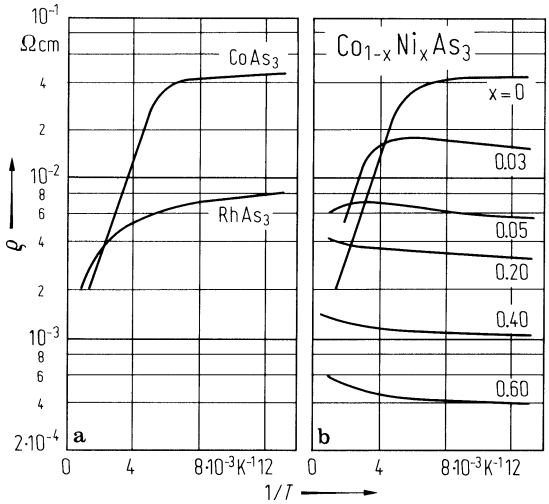

Fig. 2.

$Co_{1-x}Fe_xAs_3$ and $Ni_{1-x}Fe_xAs_3$. Resistivity vs. reciprocal temperature [62P].

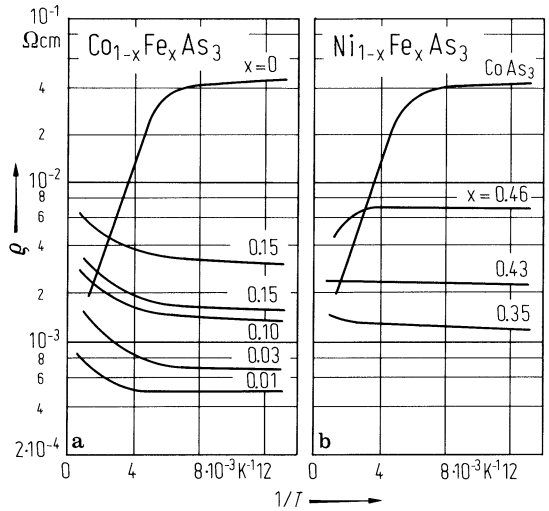

Fig. 3.

$CoSb_3$. Electrical conductivity vs. reciprocal temperature [56D].

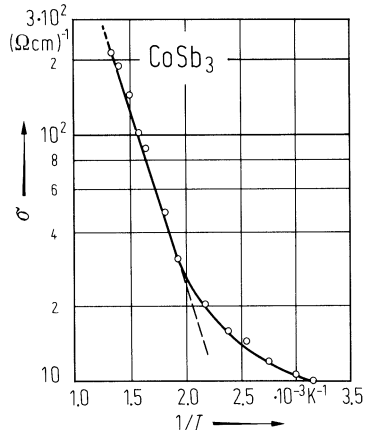

Fig. 4.

$Co_{1-x}Ni_xSb_3$. Conductivity vs. reciprocal temperature [57D].

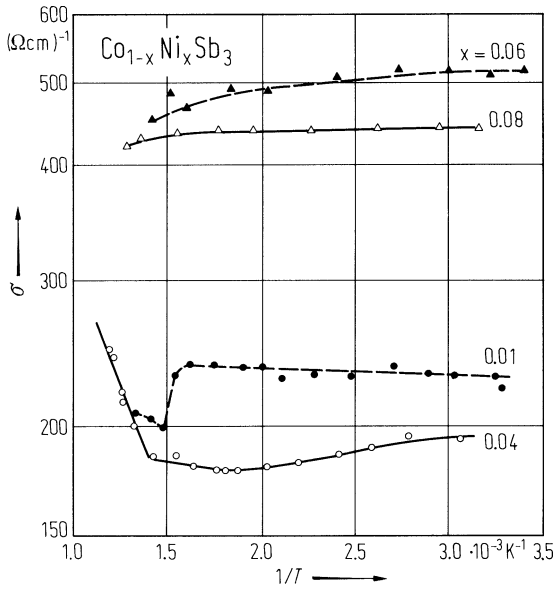

Fig. 5.

$CoSb_3$ and $Co_{1-x}Ni_xSb_3$. Thermoelectric power (circles) vs. reciprocal temperature for $CoSb_3$ [56D] and its room-temperature value (triangles) vs. concentration x for $Co_{1-x}Ni_xSb_3$ [57D].

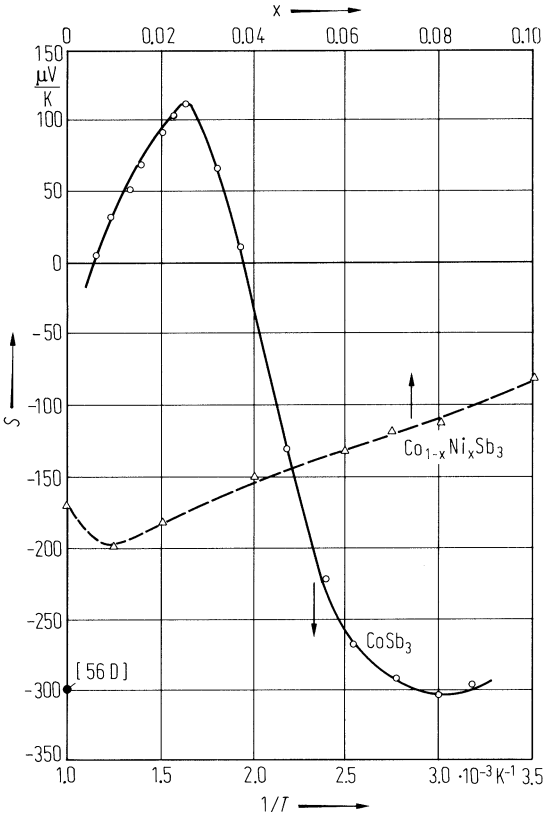

Fig. 6.

$Co_{1-x}Ni_xSb_3$. Thermoelectric power vs. reciprocal temperature [57D]. Concluding from Fig. 5 the curves for x = 0.06 and x = 0.08 should be interchanged.