STRUCTURAL AND ELECTRIC CHARACTERISTICS OF $R_{1.9}Cu_{9.2}Sn_{2.8}$ COMPOUNDS (R = Ce, Sm, Gd-Lu)

M. Rudchenko[1], L. Romaka[1], B. Kuzhel[1], V.V. Romaka[2,3], M. Konyk[1], Yu. Stadnyk[1]

[1]Ivan Franko National University of Lviv, Kyryla and Mefodiya Str., 6, 79005, Lviv, Ukraine
[2]Lviv Polytechnic National University, Ustyyanovycha Str. 5, 79013, Lviv, Ukraine
[3]Leibniz Institute for Solid State and Materials Research Dresden, Helmholtzstr. 20, 01069 Dresden, Germany

A series of isotypic $R_{1.9}Cu_{9.2}Sn_{2.8}$ compounds, where R = Ce, Sm, Gd-Lu, was synthesized by arc-melting, annealed at 1070 K and studied by X-ray powder diffraction and scanning electron microscopy. The $R_{1.9}Cu_{9.2}Sn_{2.8}$ stannides crystallize in a partly disordered substitution variant of the $CeNi_5Sn$ structure type (space group $P6_3/mmc$) [1, 2].

For our investigation the samples were synthesized by a direct twofold arc melting of the constituent metals (rare earth, purity of 99.9 wt.%; copper, purity of 99.99 wt.%; and tin, purity of 99.999 wt.%) under high purity Ti-gettered argon atmosphere on a water-cooled copper bottom. For better homogenization the alloys were re-melted twice. The pieces of the as-cast buttons were annealed for two weeks at 1070 K in evacuated silica

tubes. Then the ampules were quenched in ice water. The prepared samples are stable in air.

The detailed crystal structure refinements were performed on $R_{13}Cu_{67}Sn_{20}$ samples (R=Tb, Dy, Ho) using the starting model of the $Dy_{1.9}Cu_{9.2}Sn_{2.8}$ structure type (space group $P6_3/mmc$, disordered variant of the $CeNi_5Sn$ structure type, STOE STADI P diffractometer (linear PSD detector, $2\theta/\omega$-scan; Cu $K\alpha_1$ radiation, curved germanium (1 1 1) monochromator). Refined atomic coordinates and displacement parameters for $Tb_{1.9}Cu_{9.2}Sn_{2.8}$ compound are listed in Table. The refinements of the site occupancies showed that occupancy of 2*b* position for Tb1 atoms is 0.88, and 2c position is occupied by statistical mixture (Sn/Cu). Thus, the chemical formula of the compound should be written as $Tb_{1.9}Cu_{9.2}Sn_{2.8}$ and is in a good agreement with electron probe microanalysis ($Tb_{13.60}Cu_{66.32}Sn_{20.08}$).

Table

Atomic positional and isotropic displacement parameters for the $Tb_{1.9}Cu_{9.2}Sn_{2.8}$ compound (R_p = 0.0847, R_{wp} = 0.0565, R_{Bragg} = 0.0566)

Atom	Wyckoff position	*x*/*a*	*y*/*b*	*z*/*c*	$B_{iso}\cdot 10^2$ (nm^2)	Occupancy
Tb1	2*d*	1/3	2/3	3/4	1.17(8)	0.88
Tb2	2*a*	0	0	0	1.22(6)	1
Cu1	12*k*	0.1650(4)	0.3300(1)	0.1427(1)	0.33(1)	1
Cu2	4*f*	1/3	2/3	0.0400(2)	1.25(1)	1
Cu3	2*b*	0	0	1/4	1.11(1)	1
Sn	4*f*	1/3	2/3	0.5854(1)	0.64(5)	1
(Sn/Cu)	2*c*	1/3	2/3	1/4	1.42(9)	0.82/0.18

The observed, calculated and difference X-ray patterns of the $Tb_{1.9}Cu_{9.2}Sn_{2.8}$ compound are shown in Fig. 1.

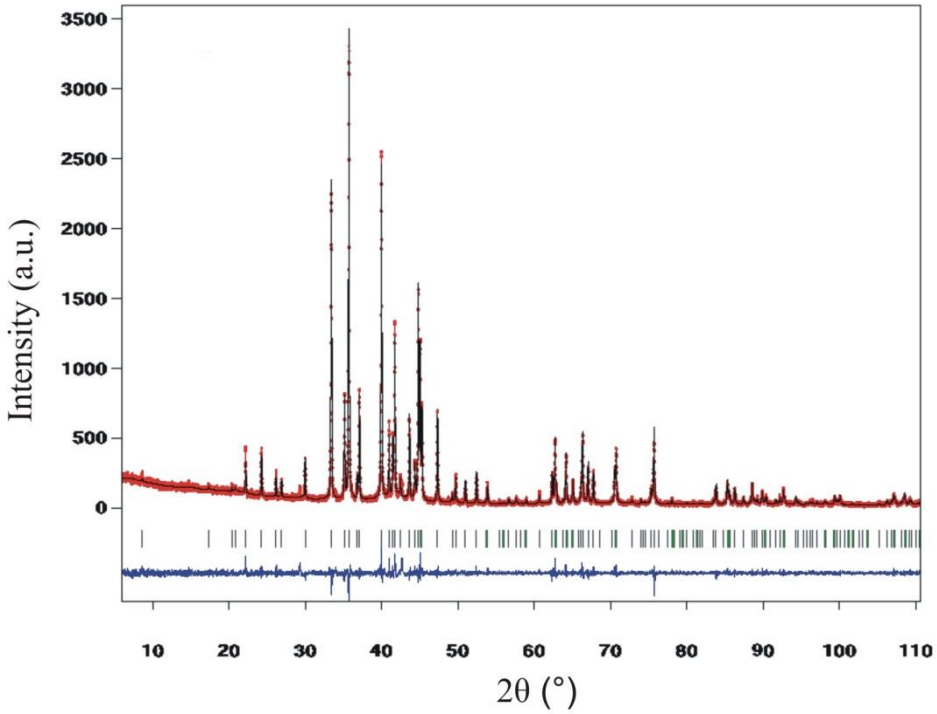

Fig. 1. The observed, calculated and difference in X-ray patterns of the $Tb_{1.9}Cu_{9.2}Sn_{2.8}$ compound

The electrical resistivity (ρ) of the $R_{1.9}Cu_{9.2}Sn_{2.8}$ compounds was measured in the temperature range 4.2-300 K employing a two-probe method. All investigated compounds exhibit a metallic-like type of conductivity. No anomaly on the $\rho(T)$ dependence for $Lu_{1.9}Cu_{9.2}Sn_{2.8}$ stannide was observed due to its Pauli paramagnetism [3]. For the compounds with magnetic rare-earths R = Gd, Tb, and Dy, some change of a slope on the $\rho(T)$ dependencies is observed at the transition temperature (T_{tr} = 10.3, 9.6, 8.9 K, respectively) which corresponds to the temperature of their magnetic ordering.

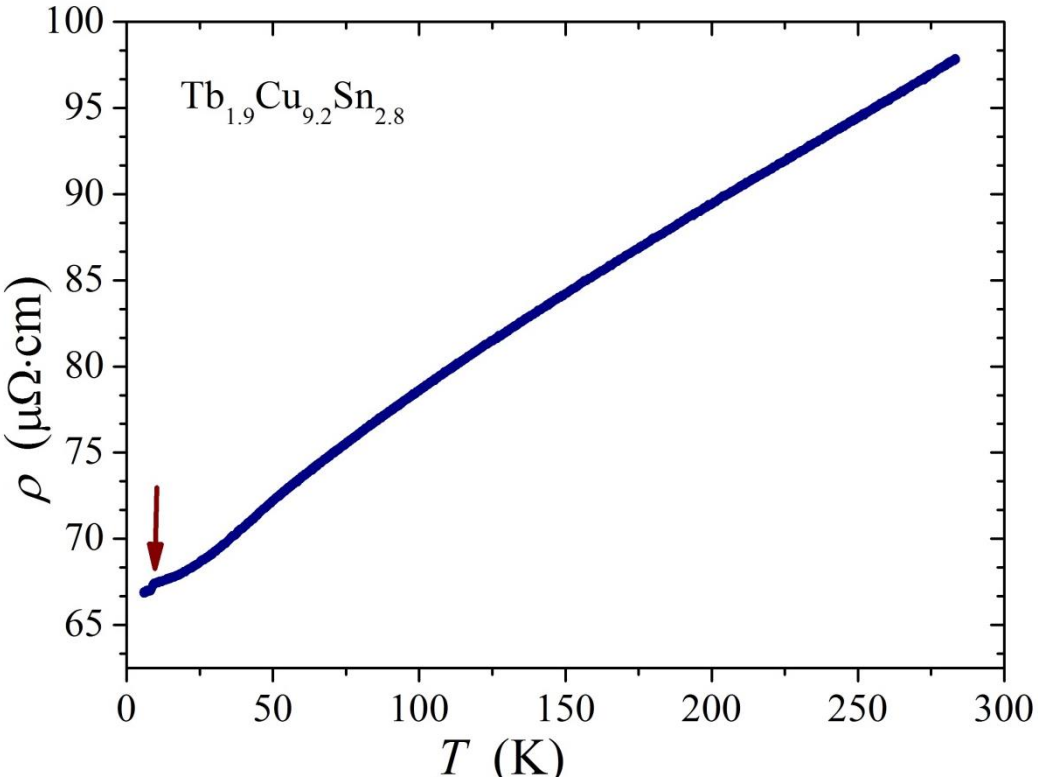

Fig. 2. Temperature dependence of electric resistivity of the $Tb_{1.9}Cu_{9.2}Sn_{2.8}$ compound

The resistivity of the $Ce_{1.9}Cu_{9.2}Sn_{2.8}$ compound has a higher magnitude compared to the other $R_{1.9}Cu_{9.2}Sn_{2.8}$ stannides being about 145 μΩ·cm at 4.2 K, it reaches 172 μΩ·cm at 300 K. At low temperatures change of the slope on the $\rho(T)$ dependence is observed at 18 K which can indicate the magnetic ordering of the $Ce_{1.9}Cu_{9.2}Sn_{2.8}$ compound.

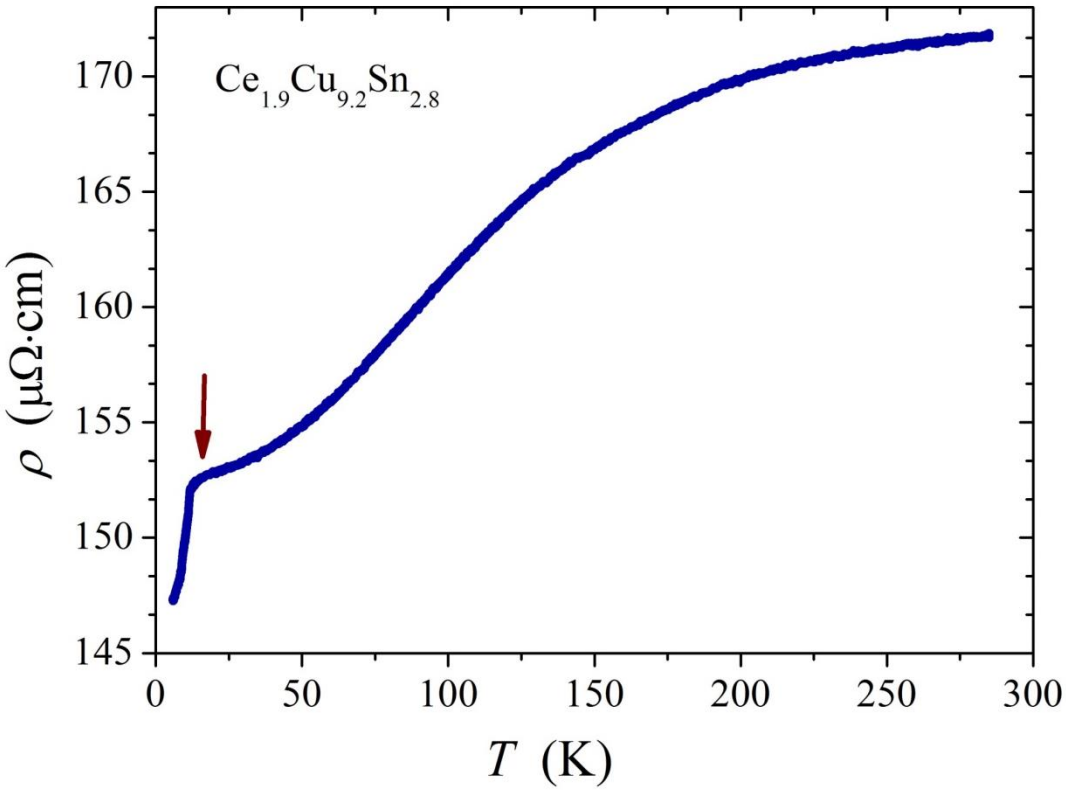

Fig. 3. Temperature dependence of electric resistivity of the $Ce_{1.9}Cu_{9.2}Sn_{2.8}$ compound

For the $R_{1.9}Cu_{9.2}Sn_{2.8}$ compounds with Ho, Er, and Tm, no anomaly on the $\rho(T)$ dependencies was observed down to 4.2 K.

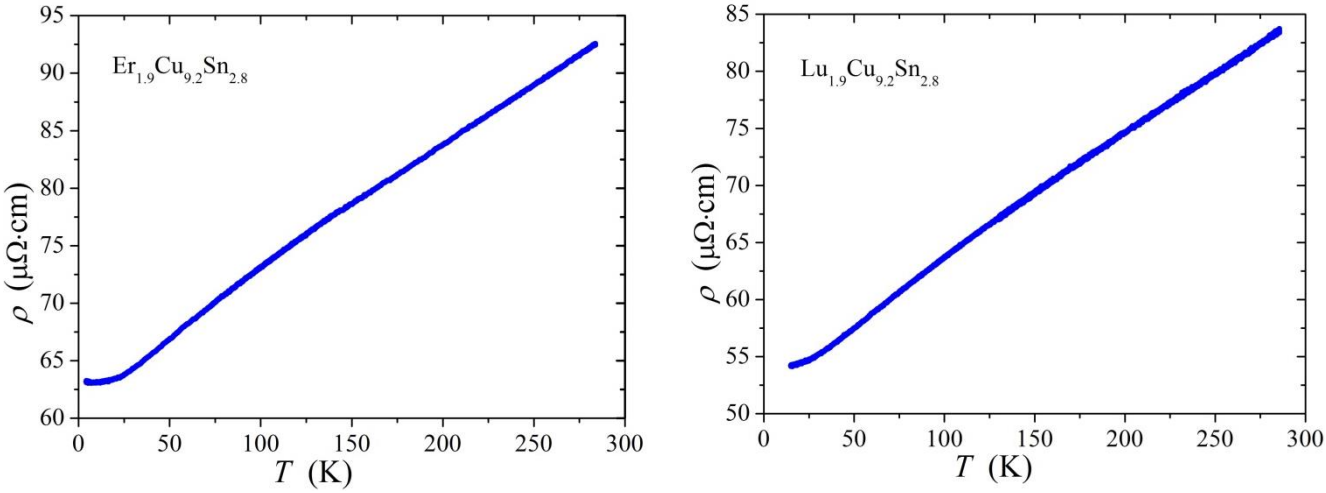

Fig. 4. Temperature dependence of electric resistivity of the $Er_{1.9}Cu_{9.2}Sn_{2.8}$ and $Lu_{1.9}Cu_{9.2}Sn_{2.8}$ compounds

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