Structure and Properties of the Stannides CeAuSn, $Ce_3Rh_4Sn_{13}$, and $Ce_3Ir_4Sn_{13}$

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CeAuSn, $Ce_3Rh_4Sn_{13}$, and $Ce_3Ir_4Sn_{13}$ were prepared by reaction of the elements in an arc-melting furnace and subsequent annealing at 970 K for two weeks. The three stannides were investigated by X-ray powder and single crystal techniques. CeAuSn crystallizes with the NdPtSb type, space group $P6_3mc$: a = 472.7(2), c = 771.6(3) pm, $wR2$ = 0.0230, 208 F^2 values, 11 variable parameters, and BASF = 0.40(2). The gold and tin atoms form a pronounced two-dimensional [AuSn] polyanion which consists of slightly puckered Au_3Sn_3 hexagons. ^{119}Sn Mössbauer data at 78 K show one signal at an isomer shift of δ = 1.90(7) mm/s subjected to unresolved quadrupole splitting of ΔE_Q = 0.55(2) mm/s. $Ce_3Rh_4Sn_{13}$ and $Ce_3Ir_4Sn_{13}$ adopt the cubic $Yb_3Rh_4Sn_{13}$ type structure, space group $Pm3n$: a = 970.51(3) pm, $wR2$ = 0.0721, 267 F^2 values ($Ce_3Rh_4Sn_{13}$) and a = 972.29(6) pm, $wR2$ = 0.0850, 267 F^2 values ($Ce_3Ir_4Sn_{13}$) with 14 variable parameters for each refinement. Striking structural motifs in $Ce_3Rh_4Sn_{13}$ are condensed distorted trigonal [$RhSn_6$] prisms with Rh-Sn distances of 266 pm. The polyhedral network leaves two different cages which are occupied by cerium (6c position) and tin (2a position) atoms. The Sn2 atoms show occupancy parameters of only 92% ($Ce_3Rh_4Sn_{13}$) and 76% ($Ce_3Ir_4Sn_{13}$) and an extremely large displacement parameter indicating a rattling of these atoms within the icosahedral Sn_{12} cages. Magnetic susceptibility measurements of $Ce_3Rh_4Sn_{13}$ show paramagnetic behavior down to 2 K with an experimental magnetic moment of 2.45(2) μ_B/Ce. No magnetic ordering is observed. Magnetization measurements show a moment of 0.78(2) μ_B/Ce at 2 K and 5.5 T. Resistivity data reveal only a very weak temperature dependence. The two crystallographically different tin sites are resolved in the ^{119}Sn Mössbauer spectrum which shows a signal at δ = 2.12(1) mm/s subject to quadrupole splitting of 1.54(1) mm/s, superimposed by a singlet at δ = 2.47(1) mm/s. The Seebeck coefficient of $Ce_3Rh_4Sn_{13}$ is within a few μV/K of zero over the temperature range of 10 - 300 K.