Abstract

The scope of the present thesis is the synthesis and analysis of structural and physical properties of filled Pt-Ge-based skutterudites, $EpPt_4Ge_{12-x}Sb_x$ (Ep = electropositive elements) and $LaPt_{4-x}M_xGe_{12}$ (M = transition metal elements), with specifically chosen substituents. Skutterudites like {Ep=La,Ba,Sr}Pt_4Ge_{12} are ternary cage forming compounds, crystallizing in a bcc-type structure, and p-type materials. They exhibit a superconducting ground state, with T_c around 8 K (La) or 5 K (Ba, Sr), concomitant with rather poor thermoelectric capabilities. Furthermore, $LaPt_4Ge_{12}$ is occasionally discussed to be a two-gap superconductor. Based on partial substitutions of Ge by Sb, previous results revealed a suppressed superconducting state and a simultaneous shift towards enhanced thermoelectric properties in $LaPt_4Ge_{12}$. Previous DFT calculations already revealed that in $LaPt_4Ge_{12-x}Sb_x$, for $x = 5$, a gap opens and $x > 5$ should be a n-type material. Thus, {La,Ba,Sr}$Pt_4Ge_{12-x}Sb_x$ sample series were synthesized by arc melting, analyzed by EPMA and XPD, and several temperature as well as field dependent physical properties were studied. For $LaPt_4Ge_{12-x}Sb_x$, a sample series with three compounds at the solubility limit was fabricated. Here, a maximum solubility of $x = 4.85$ and a thermoelectric figure of merit around 0.16, at 750 K, could be achieved. Moreover, {Ba,Sr}$Pt_4Ge_{12-x}Sb_x$ sample series, with nine different antimony contents each, from $x = 0$ up to the solubility limit were produced. Experimental results suggest BCS type-II superconductivity for both sample series up to $x = 2.71$ (Ba) and $x = 2.56$ (Sr). Moreover, the results indicate a vanishing superconducting state in both cases for $x > 4$. DFT calculations locate the Fermi energy close to (or into) a pseudogap for $x = 6$ and indicate therefore n-type behavior for $x > 6$. Here, a maximum solubility $x = 6.06$ (Ba) and $x = 5.73$ (Sr) could be achieved. However, both exhibit still p-type conductivity, in case of $x = 6.06$ (Ba) caused by a slightly reduced amount of filler atoms. Nevertheless, a four-fold (Ba) and six-fold (Sr) larger power factor in comparison to $x = 0$, at roughly 800 K, can be stated at the solubility limit. Apart from that, compounds with partial substitutions of Pt by Au in {La,Ba}Pt_4Ge_{12} were recently published. Based on this, small samples of $LaPt_{4-x}M_xGe_{12}$, where M = Ni, Pd, Fe, Co, Rh, Ir, Cu or Ag and $x = 1$ were produced. A subsequent analysis by EPMA indicated a maximum solubility for Ni. Thus, a sample series of $LaPt_{4-x}Ni_xGe_{12}$, with $x = 0$, $x = 0.09$ and $x = 0.18$, was synthesized and physical properties were measured. Taking an identified $La_2Pt_3Ge_5$ superconducting secondary phase into account ($T_c \approx 8$ K), the compounds can be also assumed to be BCS type-II superconductors with $T_c \approx 7.8$ K (for both $x = 0$ and $x = 0.09$) and $T_c \approx 7$ K ($x = 0.18$). However, unconventional superconductivity can not be fully excluded.