TCNOBL1 - TCS Noble Metal-based Alloy Database

TCNOBL1 is a thermodynamic database developed by Thermo-Calc software for noble (or precious) metal based alloys. It is intended for applications in jewelry, dental alloys, decoration industries, and delicate components in scientific instruments. For soldering and other applications, TCSLD and other relevant databases are available from Thermo-Calc Software.

In total 21 elements are included:

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<th>Co</th>
<th>Cr</th>
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A hybrid approach of experiments, first-principles calculations and CALPHAD modeling have been used to obtain thermodynamic descriptions of the constituent binary and ternary systems over the whole composition and temperature ranges. In total, 204 binary systems and 61 ternary systems have been assessed, as listed in the section Critically Assessed Systems in TCNOBL. These assessed binary and ternary systems can be calculated with the BINARY module and the TERNARY module in Thermo-Calc, respectively.

TCNOBL contains 321 solution and intermetallic phases in total, which includes nearly all stable phases in the assessed systems that may form in as-cast and aged noble-based alloys. A full list of the phases and their models and constituents can be found in Included Phases in TCNOBL.

The database can be used to calculate various phase diagrams and property diagrams in the assessed systems or even extrapolated higher-order systems. The extrapolation to higher-order systems helps to understand the phase equilibria in multi-component industrial noble alloys, so as to predict the phase formation, phase fractions and phase compositions or to calculate the driving force of forming a phase. The database can also be used for predicting solidification behavior of noble alloys with the SCHEIL_GULLIVER module in Thermo-Calc and simulating general diffusion controlled phase transformations with the Diffusion Module (DICTRA) or multi-particle precipitations during aging treatment with the Precipitation Module (TC-PRISMA).

The database has been validated against many commercial noble alloys and available experimental information. Some selected examples of calculated binary phase diagrams, ternary phase diagrams and thermodynamic properties of these assessed systems can be found in Examples of Calculations Using TCNOBL.
Critically Assessed Systems in TCNOBL

Assessed Binary Systems (204 in total)

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Examples of Calculations Using TCNOBL

Fig. 1 Calculated Au-Cu phase diagram.

Fig. 2 Calculated Ag-Pt phase diagram.
Fig. 3 Calculated Cu-Pd phase diagram.

Fig. 4 Calculated Ag-Zn phase diagram [1998, Gómez-Acebo].
Fig. 5 Calculated Ag-Au-Cu vertical section at (a) 25 at. % Au, and (b) 50 at. % Au along with experimental data [1985, Kogachi].

Fig. 6 Calculated Ag-Cu-Ni isothermal sections at (a) 1250 °C, and (b) 1400 °C compared with experimental data [1933, Guertler].
Fig. 7 Calculated Au-Ni-Pt isothermal sections at (a) 950 °C, and (b) 1250 °C compared with experimental data [1973, Carmio].

Fig. 8 Calculated Pd-Rh-Ru isothermal section at 1400 °C along with experimental data [1984, Raevskaya].
Fig. 9 Calculated liquidus surface projection of the Ag-Cu-Ge system in comparison with experimental data [2017, Guo; 2015, Akhmetova; 2009, Nagels].

Fig. 10 Validation results on a) liquidus and b) solidus for a large number of commercial noble metal alloys.
References


### Included Phases in TCNOBL

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<td>Ag3Sn, Au3In, Tao 1 in Cu-Ni-Sn</td>
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<tr>
<td>AL5CO2_D811</td>
<td>(Al)5(Co,Rh)2</td>
<td>This is Al5Co2 and Al5Rh2.</td>
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<td>AL5FE2</td>
<td>(Al)5(Fe)2</td>
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<td>AL5FE4</td>
<td>(Al,Fe)1</td>
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<td>AL6MN</td>
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<tr>
<td>AL7RH3</td>
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<tr>
<td>AL8CR5_H</td>
<td>(Al)8(Cr)5</td>
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<tr>
<td>AL8CR5_L</td>
<td>(Al)8(Cr)5</td>
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<td>AL8MN5</td>
<td>(Al)12(Mn)5(Al,Mn)9</td>
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<td>AL9CO2</td>
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<td>This is Al9Co2, Al9Rh2 and Ga9Rh2.</td>
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<td>AL9CR4_H</td>
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<td>AL9CR4_L</td>
<td>(Al)9(Cr)4</td>
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<td>AL9IR2</td>
<td>(Al)0.82(Ir)0.18</td>
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<td>ALAU2_HT</td>
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<td>ALAU2_LT</td>
<td>(Al)1(Au,Au,Cu)2</td>
<td>AlAu2_LT</td>
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<td>AlCu_Eta</td>
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<td>(Al,Zn)4(Al,Cu,Zn)1(Ag,Cu)8</td>
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<td>ALCU_ZETA</td>
<td>(Ag,Cu)0.55(Al,In)0.45</td>
<td>AlCu_Zeta, Cu11In9</td>
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<td>ALPHA_GE3RU2</td>
<td>(Ge)3(Ru)2</td>
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<td>ALPT_B20</td>
<td>(Al)1(Ni,Pt,Rh)1</td>
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<td>Phase Name</td>
<td>Formula</td>
<td>Comments</td>
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<td>(Al)1(Re)2</td>
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<td>(Al,Ti)3(Al,Ti)1</td>
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<td>AU10SN_D024</td>
<td>(Au,Ga,Ge,In,Sn)</td>
<td>The AuIn_Alpha1, AuSn_Beta</td>
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<td>AU11MN4</td>
<td>(Au)0.73(Mn)0.27</td>
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<td>AU11ZN14</td>
<td>(Au)11(Zn)14</td>
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<td>AU13MN4</td>
<td>(Au)0.77(Mn)0.23</td>
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<td>AU15ZN85_EPSILON_PRIME</td>
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<td>AU2MN</td>
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<td>AU2TI</td>
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<td>AU33MN9</td>
<td>(Au)0.79(Mn)0.21</td>
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<td>AU3MN</td>
<td>(Au)0.75(Mn)0.25</td>
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<td>AU3ZN_ALPHA1</td>
<td>(Au)3(Au,Zn)1(Zn)1</td>
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<td>AU3ZN_ALPHA2</td>
<td>(Au)0.75(Zn)0.25</td>
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<td>AU4IN3SN3</td>
<td>(Au)0.4(In,Sn)0.3(In,Sn)0.3</td>
<td>This is the Au4In3Sn3 ternary phase</td>
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<td>AU4MN</td>
<td>(Au)0.8(Mn)0.2</td>
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<tr>
<td>AU4TI</td>
<td>(Au,Ti)0.2(Au)0.8</td>
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<td>AU4ZN_ALPHA3</td>
<td>(Au)18(Au,Zn)7(Zn)3</td>
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<td>AU5MN2</td>
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<tr>
<td>AU5ZN3</td>
<td>(Au)5(Zn)3</td>
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<td>AU5ZN8_GAMMA</td>
<td>(Au,Zn)2(Au,Zn)2(Au,Zn)3(Zn)6</td>
<td>Au5Zn8</td>
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<td>AU7GA2_HT</td>
<td>(Au)0.79(Ga)0.21</td>
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<td>(Au)7(Ga)2</td>
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<tr>
<td>Phase Name</td>
<td>Formula</td>
<td>Comments</td>
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<tr>
<td>AU7GA3</td>
<td>((\text{Au})7(\text{Ga})3)</td>
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<tr>
<td>AU7IN3</td>
<td>((\text{Au})0.7(\text{In})0.3)</td>
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<tr>
<td>AU9IN4_GAMMA_D83</td>
<td>((\text{Au})0.62(\text{Au,In})0.08(\text{Au,In})0.23(\text{In})0.08)</td>
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<tr>
<td>AUCOSN4</td>
<td>((\text{Au})0.15(\text{Co})0.25(\text{Sn})0.6)</td>
<td>This is the AuCoSn4 ternary phase</td>
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<tr>
<td>AUGA_B31</td>
<td>((\text{Au})1(\text{Ga})1)</td>
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<tr>
<td>AUIN</td>
<td>((\text{Au})0.5(\text{In,Sn})0.5)</td>
<td>AuIn</td>
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<tr>
<td>AUIN_BETA</td>
<td>((\text{Au})0.79(\text{In})0.21)</td>
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<tr>
<td>AUIN_BETA_PRIME</td>
<td>((\text{Au})0.78(\text{In})0.22)</td>
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<tr>
<td>AUMN2</td>
<td>((\text{Au})0.33(\text{Mn})0.67)</td>
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<tr>
<td>AUNI2SN4</td>
<td>((\text{Sn})0.57(\text{Au})0.14(\text{Ni})0.29)</td>
<td>This is the AuNi2Sn4 ternary phase</td>
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<td>AUPT2SN4_TAO</td>
<td>((\text{Au})1(\text{Pt})2(\text{Sn})4)</td>
<td>This is the AuPt2Sn4 ternary phase</td>
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<tr>
<td>AUSN_ZETA_PRIME</td>
<td>((\text{Au})0.84(\text{In,Sn})0.16)</td>
<td>AuSn_Zeta_Prime</td>
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<tr>
<td>AUSN2_OP24</td>
<td>((\text{Au,Cu,Pt})0.33(\text{Sn})0.67)</td>
<td>AuSn2</td>
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<tr>
<td>AUSN4_OS20</td>
<td>((\text{Au,Cu,Ni,Pd,Pt})0.2(\text{In,Pd,Sn})0.8)</td>
<td>AuSn4, PdSn4, PtSn4</td>
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<tr>
<td>AUTI</td>
<td>((\text{Ti, Va})0.5(\text{Au,Ti})0.5)</td>
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<tr>
<td>AUTI3</td>
<td>((\text{Ti})0.75(\text{Au})0.25)</td>
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<tr>
<td>AUZN3_GAMMA2</td>
<td>((\text{Au})1(\text{Zn})3)</td>
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<tr>
<td>AUZN4_GAMMA3</td>
<td>((\text{Au})0.12(\text{Au,Zn})0.16(\text{Zn})0.72)</td>
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<td>B20_GERU</td>
<td>((\text{Ge})1(\text{Ru})1)</td>
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<tr>
<td>BCC_A2</td>
<td>((\text{Ag, Al, Au, Co, Cr, Cu, Fe, Ga, Ge, In, Ir, Mn, Ni, Pd, Pt, Re, Rh, Ru, Sn, Ti, Zn, Va})1(\text{Va})3)</td>
<td>Disordered BCC_A2 solution phase</td>
</tr>
<tr>
<td>Phase Name</td>
<td>Formula</td>
<td>Comments</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>BCC_B2</td>
<td>((\text{Ag,Al,Co,Cr,Cu,Fe,Ga,Ge,In,}I_r,\text{Mn,}\text{Ni,Pt,Re,Rh,Ru,Sn,}I_{n,}T_i,\text{Zn,Va})^{0.5}(\text{Ag,Al,Co,Cr,Cu,Fe,Ga,Ge,In,}I_r,\text{Mn,Ni,Pt,Re,Rh,Ru,Sn,}I_{n,}T_i,\text{Zn,Va})^{0.5}(\text{Va})^{3})</td>
<td>Solution of ordered BCC_B2, having Gibbs energy contribution from BCC_A2</td>
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<tr>
<td>BCT_A5</td>
<td>((\text{Ag,Al,Cu,Ga,In,Ni,Sn,Zn}))</td>
<td>Disordered BCT solution phase; Also for pure Sn</td>
</tr>
<tr>
<td>BCT_D022</td>
<td>((\text{Al,Ga,Ti})^{3}(\text{Al,}I_{t})^{1})</td>
<td>This is Al3Ti and Ga3Ti.</td>
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<tr>
<td>BETA_GE3RU2</td>
<td>((\text{Ge})^{3}(\text{Ru})^{2})</td>
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<tr>
<td>C14_LAVES</td>
<td>((\text{Cr,Fe,Mn,}T_i,\text{Zn})^{2}(\text{Cr,Fe,Mn,}T_i,\text{Zn})^{1})</td>
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<tr>
<td>C15_LAVES</td>
<td>((\text{Co,}C_r,\text{Ti})^{2}(\text{Co,}C_r,\text{Ti})^{1})</td>
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<td>C36_LAVES</td>
<td>((\text{Co,}C_r,\text{Ti})^{2}(\text{Co,}C_r,\text{Ti})^{1})</td>
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<td>CBCC_A12</td>
<td>((\text{Al,}C_r,\text{Co,}C_r,\text{Cu,Fe,In,}I_r,\text{Mn,Ni,Pt,Re,}R_u,\text{Sn,}I_{n,}T_i,\text{Zn,}V_i)^{(1}(\text{Va})^{1})</td>
<td>Disordered CBCC_A12 solution phase; Also for pure Mn</td>
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<tr>
<td>CHI_A12</td>
<td>((\text{Re})^{24}(\text{Ti})^{10}(\text{Re})^{24})</td>
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<tr>
<td>CO2SI_C23</td>
<td>((\text{Al,Co,In,Pd,Sn,Zn})^{1}(\text{Al,Co,}N_i,\text{Ni,Pd,Pt})^{2})</td>
<td>AlPd2, AlPt2, InPd2, Pd2Sn, Pd2Zn</td>
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<tr>
<td>CO3GE</td>
<td>((\text{Co})^{0.75}(\text{Ge})^{0.25})</td>
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<tr>
<td>CO5GE2</td>
<td>((\text{Co})^{0.71}(\text{Ge})^{0.29})</td>
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<tr>
<td>CO5GE3</td>
<td>((\text{Co,Rh,Va})^{0.12}(\text{Co,Rh})^{0.5}(\text{Co,Ge,Sn})^{0.38})</td>
<td>Co5Ge3 solid solution and Rh3Sn2.</td>
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<tr>
<td>CO5GE3_ALPHA</td>
<td>((\text{Co})^{0.62}(\text{Ge})^{0.38})</td>
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<tr>
<td>CO5GE7</td>
<td>((\text{Co})^{0.42}(\text{Ge})^{0.58})</td>
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<td>COGE</td>
<td>((\text{Co,Ge})^{0.5}(\text{Co,Ge})^{0.5})</td>
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<td>COGE2</td>
<td>((\text{Co})^{0.33}(\text{Ge})^{0.67})</td>
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<td>COSN_HP6</td>
<td>((\text{Co,Fe,}N_{i})^{0.5}(\text{In,}S_n)^{0.5})</td>
<td>This is CoSn, FeSn and InNi</td>
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<td>COSN3_OS32</td>
<td>((\text{Co,Pd})^{0.25}(\text{Pd,}S_n)^{0.75})</td>
<td>CoSn3, PdSn3</td>
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<td>COZN_DELTA</td>
<td>((\text{Co})^{0.12}(\text{Zn})^{0.88})</td>
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<td>Phase Name</td>
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<td>Comments</td>
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<td>COZN_GAMMA_D82</td>
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<td>Zn11Co2 Prototype Zn9(Zn0.5Fe0.5)2Fe2 (cI52, I-43m)</td>
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<td>COZN_GAMMA1</td>
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<td>COZN_GAMMA2</td>
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<td>COZN_HT</td>
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<td>COZN_LT</td>
<td>(Co,Zn)1(Va)1</td>
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<td>CR11GE19</td>
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<td>CR11GE8</td>
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<td>CR3SI_A15</td>
<td>(Cr,Ir,Ti)3(Cr,Ga,Ge,Ir,Rh,Ru)1</td>
<td>Cr3Ir, Cr3Ga, Cr3Ge, Cr3Rh, Cr3Ru, Ti3Ir. Prototype Cr3Si.</td>
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<td>Cu10Sn3</td>
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<td>CU2IN_LT</td>
<td>(Cu)0.64(In)0.36</td>
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<td>CU2IN3SN</td>
<td>(Cu)0.33(In)0.5(Sn)0.17</td>
<td>This is the Cu2In3Sn ternary phase</td>
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<td>Comments</td>
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<td>CU3GE_EPSILON</td>
<td>(Ag,Cu)0.77(Ge)0.23</td>
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<td>CU3GE_ETA</td>
<td>(Ag,Cu)0.75(Ge)0.25</td>
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<td>CU3GE_THETA</td>
<td>(Ag,Cu)0.73(Ge)0.27</td>
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<td>CU3IN_GAMMA_D83</td>
<td>(Ag,Cu)0.65(Ag,Cu,In)0.12(In,Sn)0.23</td>
<td>Cu9In4 Prototype Cu9Al4 (cP52, P-43m) with solubility of Ag, Sn.</td>
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<td>CU3SN</td>
<td>(Au,Cu,Sn)3(Cu,In,Sn)1</td>
<td>Cu3Sn with solubility of Au and In.</td>
</tr>
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<td>CU3TI2</td>
<td>(Cu)3(Ti)2</td>
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<td>CU41SN11</td>
<td>(Cu,Sn,Zn)41(Cu,In,Sn,Zn)11</td>
<td>Cu41Sn11 with solubility of In and Zn.</td>
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<td>CU4MNSN</td>
<td>(Cu)0.67(Sn)0.17(Mn)0.17</td>
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<td>CU4TI1</td>
<td>(Cu,Ti)4(Cu,Ti)1</td>
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<tr>
<td>CU4TI3</td>
<td>(Cu)4(Ti)3</td>
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<td>CU5ZN8_GAMMA_D83</td>
<td>(Ag,Al,In,Ni,Zn)4(Ag,Al,Cu,In,Ni,Zn)1(Ag,Cu,In,Sn,Zn)8</td>
<td>Ag9In4, Ag5Zn8, Al4Cu9, Cu5Zn8, In7Ni3, Ni5Zn8 Prototype Cu9Al4 (cP52, P-43m)</td>
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<td>CU6SN5_HT_NIAS</td>
<td>(Ag,Au,Co,Cu,Mn,Ni,Pd,Pt,Va)1(Ag,Al,Cu,Ge,In,Ni,Sn)1(Co,Cu,Mn,Ni,Pd,Va)1</td>
<td>AlCu_D81, AuSn_Delta, Co3Sn2, Cu2In_HT, Cu6Sn5_HT, Ge3Ni5_HT, InNi2_HT, Mn(2-x)Sn, Ni3Sn2, Pd2Sn_HT, PtSn</td>
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<tr>
<td>CU6SN5_LT</td>
<td>(Cu)1(Cu,Sn)1(Sn)1</td>
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<td>CU77INSN23</td>
<td>(Cu)0.77(In,Sn)0.23</td>
<td>This is the C77InSn23 ternary phase</td>
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<td>CU7IN3_DELTA</td>
<td>(Cu)0.7(In,Sn)0.3</td>
<td>Cu7In3_Delta</td>
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<td>(Cu)6(Cu,Ga)6(Ga)1</td>
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<td>CU9GA4_1</td>
<td>(Cu)6(Cu,Ga)3(Cu,Ga)3(Ga)1</td>
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<tr>
<td>CU9GA4_2</td>
<td>(Cu)3(Cu,Va)3(Cu,Ga)3(Ga)4</td>
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<tr>
<td>Phase Name</td>
<td>Formula</td>
<td>Comments</td>
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<tr>
<td>CUB9GA4_3</td>
<td>(Cu,Va)6(Cu,Ga)3(Ga)4</td>
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</tr>
<tr>
<td>CUBIC_A13</td>
<td>(Ag,Al,Co,Cr,Cu,Fe,In,Ir,Mn,Ni,Pd,Pt,Re,Ru,Sn,Ti,Zn)</td>
<td>CUBIC_A13 solution phase</td>
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<tr>
<td>CUGA_THETA</td>
<td>(Cu)0.78(Ga)0.22</td>
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<td>CUGA2</td>
<td>(Cu)1(Ga)2</td>
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<tr>
<td>CUNI2SN</td>
<td>(Cu)0.23(Ni)0.5(Sn)0.27</td>
<td>Cu-Ni-Sn, tao 2</td>
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<td>CUP_G11</td>
<td>(Au,Cu,Pt)0.5(Au,Cu,Pt)0.5(Va)1</td>
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<td>CUTI_B11</td>
<td>(Cu,Ti)1(Cu,Ti)1</td>
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<td>(Cu,Ti)1(Ti)3</td>
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<tr>
<td>DIAMOND_A4</td>
<td>(Ag,Au,Ga,Ge,Sn,Ti)</td>
<td>Disordered DIAMOND solution phase; Also for pure Ge</td>
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<tr>
<td>DIS_SIG</td>
<td>(Co,Cr,Fe,Mn,Re,Ru)</td>
<td>Part of the description of SIGMA phase.</td>
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<td>FCC_A1</td>
<td>(Ag,Al,Au,Co,Cr,Cu,Fe,Ga,Ge,In,Ir,Mn,Ni,Pd,Pt,Re,Rh,Ru,Sn,Ti,Zn)1(Va)1</td>
<td>Disordered FCC_A1 solution phase, e.g. (Ag), (Au), (Cu), (Ni) etc</td>
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<td>FE3SN2</td>
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<td>FE5SN3</td>
<td>(Fe)5(Sn)3</td>
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<td>(Fe)0.06(Fe,Zn)0.18(Zn)0.53(Zn)0.24</td>
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<td>FEZN_GAMMA_D81</td>
<td>(Fe)0.14(Fe,Zn)0.12(Zn)0.74</td>
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<td>FEZN_GAMMA_D82</td>
<td>(Fe,Zn)0.15(Fe,Zn)0.15(Fe,Zn)0.23(Zn)0.46</td>
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<td>FEZN_ZETA</td>
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<td>GA11GEPT7</td>
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<td>(Ga)7(Pd)3</td>
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<td>GAMMA_D03</td>
<td>(Cu,Mn,Ni,Sn,Zn)</td>
<td>Cu3Sn Prototype BiF3 (cF16, Fm-3m)</td>
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<td>GAPD_B20</td>
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<td>GAPT</td>
<td>(Ga,Ge)0.5(Pt)0.5</td>
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<td>(Ga,Ge)0.33(Pt)0.67</td>
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<td>(Ga,Pt,Ge)0.25(Ga,Pt)0.75</td>
<td>GaPt3 with solubility of Ge.</td>
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<td>Ge3Ni5</td>
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<td>Phase Name</td>
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<td>Comments</td>
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<td>GePt3, Ni25Si9, Pt3Si_LT</td>
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<td>(Ag,Al,Au,Co,Cr,Cu,Fe,Ga,Ge,In,In,Pd,Re,Rh,Ru,Sn,Ti,Zn)1(Va)0.5</td>
<td>Disordered HCP_A3 solution phase; Also for pure Co, Re, Ru, Ti and Zn</td>
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<tr>
<td>HCP_ZN</td>
<td>(Ag,Al,Au,Co,Cr,Cu,Fe,Ga,Ge,In,In,Pd,Re,Rh,Ru,Sn,Ti,Zn)1(Va)0.5</td>
<td>Disordered HCP_ZN solution phase; Also for pure Zn</td>
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<td>HIGH_SIGMA</td>
<td>(Mn)8(Cr)4(Cr,Mn)18</td>
<td>This is sigma in the Cr-Mn binary.</td>
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<td>IN2PT3_ALPHA</td>
<td>(In)2(Pt)3</td>
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<td>(In,Pt)2(In,Pt)3</td>
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<td>IN3RH</td>
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<td>(In)4(Mn)9</td>
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<td>IN5PT6</td>
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<td>IN7PD3</td>
<td>(In)0.71(Pd)0.29</td>
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<td>IN7PT3</td>
<td>(In)7(Pt)3</td>
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<td>IN9NI13</td>
<td>(Ni,Va)1(In,Sn)1(Ni)1</td>
<td>In9Ni13 with solubility of Sn.</td>
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<td>IN9PT13</td>
<td>(In)9(In,Pt)13</td>
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<td>INNI6SN5</td>
<td>(Ni)1(In,Sn)1</td>
<td>This is the InNi6Sn5 ternary phase</td>
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<td>(In)0.34(Pd)0.66</td>
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<td>INPD3_ALPHA</td>
<td>(In)0.25(Ag,Pd)0.75</td>
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<td>INPD3_BETA</td>
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<td>INPT</td>
<td>(In,Pt)1(In,Pt)1</td>
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<td>INSN_A6</td>
<td>(In,Sn)</td>
<td>INSN_A6 solution phase</td>
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<td>INSN_GAMMA</td>
<td>(In,Sn)</td>
<td>InSn_Gamma</td>
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<td>IRIN2</td>
<td>(Co,Ir)1(In)2</td>
<td>CoIn2 and IrIn2. Prototype Mg2Cu.</td>
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<tr>
<td>IRIN3_HT</td>
<td>(Co,Ir)1(Ga,In)3</td>
<td>This is CoIn3, CoGa3 and htl-IrIn3.</td>
</tr>
<tr>
<td>IRIN3_LT</td>
<td>(Ir)1(In)3</td>
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<td>L10_FCC</td>
<td>(Al,Ag,Au,Cu,Fe,Ga,Ge,Ir,Mn,Ni,Pd,Pt,Ti,Zn)0.5(Al,Ag,Au,Cu,Fe,Ga,Ge,Ir,Mn,Ni,Pd,Pt,Ti,Zn)0.5</td>
<td>Solution of ordered L10_FCC.</td>
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<tr>
<td>L12_FCC</td>
<td>(Ag,Al,Au,Co,Cr,Cu,Fe,Ga,Ge,Ir,Mn,Ni,Pd,Pt,Rh,Ti,Zn)1(Ag,Al,Au,Co,Cr,Cu,Fe,Ga,Ge,Ir,Mn,Ni,Pd,Pt,Rh,Ti,Zn)3</td>
<td>Solution of ordered L12_FCC.</td>
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<td>LCR5GE3</td>
<td>(Cr,Ge)0.62(Cr,Ge)0.38</td>
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<td>LIQUID</td>
<td>(Ag,Al,Au,Co,Cr,Cu,Fe,Ga,Ge,Ir,Mn,Ni,Pd,Pt,Ptsn,Re,Rh,Ru,Sn,Ti,Zn)</td>
<td>Metallic LIQUID solution phase</td>
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<td>MN3PD5</td>
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<td>MN3SN2</td>
<td>(Mn)3(Sn)2</td>
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<tr>
<td>MN3TI</td>
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<td>MN4TI</td>
<td>(Mn)0.81(Ti)0.18</td>
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<td>MNNI2</td>
<td>(Mn,Ni)1(Ni)2</td>
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<tr>
<td>MNPD2</td>
<td>(Mn)1(Pd)2</td>
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<td>MNTI_LT</td>
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<td>MNZN9</td>
<td>(Mn)1(Zn)9</td>
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<tr>
<td>NI3GA2</td>
<td>(Ni)0.6(Ga)0.4</td>
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<tr>
<td>NI3GA4</td>
<td>(Ni)0.43(Ga)0.57</td>
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<td>Phase Name</td>
<td>Formula</td>
<td>Comments</td>
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<tr>
<td>NI3SN_D019</td>
<td>((Au,Co,Cu,Mn,Ni,Sn,Ti)<em>{0.75}(In,Ga,Ni,Sn,Ti)</em>{0.25})</td>
<td>This is GaTi3, InNi3, Mn3Sn, Ni3Sn_LT, Ti3Sn.</td>
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<tr>
<td>NI3SN4</td>
<td>((Cu,Ni)<em>{0.25}(In,Ni,Sn)</em>{0.25}(In,Sn)_{0.5})</td>
<td>Ni3Sn4 with solubility of In.</td>
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<tr>
<td>NI3TI_D024</td>
<td>((Ni,Ti)<em>{0.75}(Ni,Ti)</em>{0.25})</td>
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<tr>
<td>NI5GA3</td>
<td>((Ni)<em>{0.63}(Ga)</em>{0.37})</td>
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<td>NIGA4</td>
<td>((Ni)<em>{0.2}(Ga)</em>{0.8})</td>
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<td>NITI2</td>
<td>((Co,Ni,Ti)<em>{1}(Ni,Ti)</em>{2})</td>
<td>This is CoTi2 and NiTi2.</td>
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<tr>
<td>NIZN_TP2</td>
<td>((Cu,Ni,Pd,Zn)<em>{0.5}(Ni,Pd,Zn)</em>{0.5})</td>
<td>NiZn, PdZn</td>
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<td>NIZN8_DELTA</td>
<td>((Ni)<em>{1}(Zn)</em>{8})</td>
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<td>ORTHORHOMBIC_GA</td>
<td>((Ga))</td>
<td>Pure Ga.</td>
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<td>PD20SN13</td>
<td>((Pd,Sn)<em>{0.6}(Pd,Sn)</em>{0.4})</td>
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<td>PD21GE8</td>
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<td>PD25GE9</td>
<td>((Pd)<em>{25}(Ge)</em>{9})</td>
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<td>PD2GE</td>
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<td>PD2TI</td>
<td>((Pd)<em>{2}(Ti)</em>{1})</td>
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<tr>
<td>PD3GE</td>
<td>((Pd)<em>{3}(Ge)</em>{1})</td>
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<td>PD3SN2_ALPHA</td>
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<tr>
<td>PD3SN2_BETA</td>
<td>((Pd)<em>{3}(Sn)</em>{2})</td>
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<td>PD3SN2_GAMMA</td>
<td>((Pd)<em>{0.59}(Sn)</em>{0.41})</td>
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<td>PD3TI2</td>
<td>((Pd)<em>{3}(Ti)</em>{2})</td>
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<td>PD5GE</td>
<td>((Pd)<em>{5}(Ge)</em>{1})</td>
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<td>PD5TI3</td>
<td>((Pd)<em>{5}(Ti)</em>{3})</td>
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<td>PDSN2</td>
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<td>((Pd,Zn)<em>{1}(Pd,Zn)</em>{1})</td>
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<td>Phase Name</td>
<td>Formula</td>
<td>Comments</td>
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<td>RHGE</td>
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<td>(Rh)0.33(Sn)0.67</td>
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<td>Ru2SN3</td>
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<td>Ru3SN7</td>
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<td>DIS_SIG contribution is introduced in the description of this phase</td>
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<td>Disordered TETRAGONAL solution phase; Also for pure In</td>
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<td>TIZN5</td>
<td>(Ti)1(Zn)5</td>
<td></td>
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