Phase equilibria in the In–Pd–Sn ternary: Experimental study and CALPHAD modeling

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Phase equilibria of the In–Pd–Sn system were investigated by a combination of key experiments and thermodynamic modeling.

Experimental procedures

The studied alloys were smelted using high-purity metals: indium 99.9999%, palladium 99.95%, and tin 99.9% in electric arc furnace under argon atmosphere purified by preliminary melting of a getter (hafnium).

The alloys were annealed at 500 and 800°C in evacuated silica ampoules, with subsequent quenching in cold water. Annealing time of the samples at 500°C was 3648 hours, and at 800°C 1680 hours.

The alloys were examined by X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy dispersive X-ray (EDX) analysis.

The results of experimental studies, together with published data [4], were treated in the frame of CALPHAD method.

Calculation

The calculation of phase equilibria was carried out using the Thermo-Calc® software. Thermodynamic descriptions of the binary systems were accepted from [1–3]. The parameters of the (Sn) and beta phases of the In–Sn binary had to be revised to account for the new stability parameters of indium and tin from PURE5. The revised results are shown in Figure 1.

The disordered phases were described using the Redlich-Kister-Muggianu model with ternary interactions. Intermetallic phases were described by the following models:

$InPd_3$	$(In,Sn)_{0,25}(Pd)_{0,75}$
InPd	$(In,Pd,Sn)_{0,5}(Pd,Va)_{0,5}$
In_7Pd_3	$(In,Sn)_{0,71}(Pd)_{0,29}$
Pd_3Sn	$(In,Pd,Sn)_{0,25}(In,Pd,Sn)_{0,75}$
$Pd_{20}Sn_{13}$	$(In,Pd,Sn)_{0,6}(In,Pd,Sn)_{0,4}$
PdSn	$(In,Pd,Sn)_{0,5}(Pd,Va)_{0,5}$

The isostructural phases $InPd_2$ and Pd_2Sn are described by model $(Pd)_{0,667}(In,Sn)_{0,333}$.

The calculated results with superimposed experimental data obtained in this work and in [4] are presented in Figure 2. Good agreement between the calculated phase equilibria and experiment is achieved.

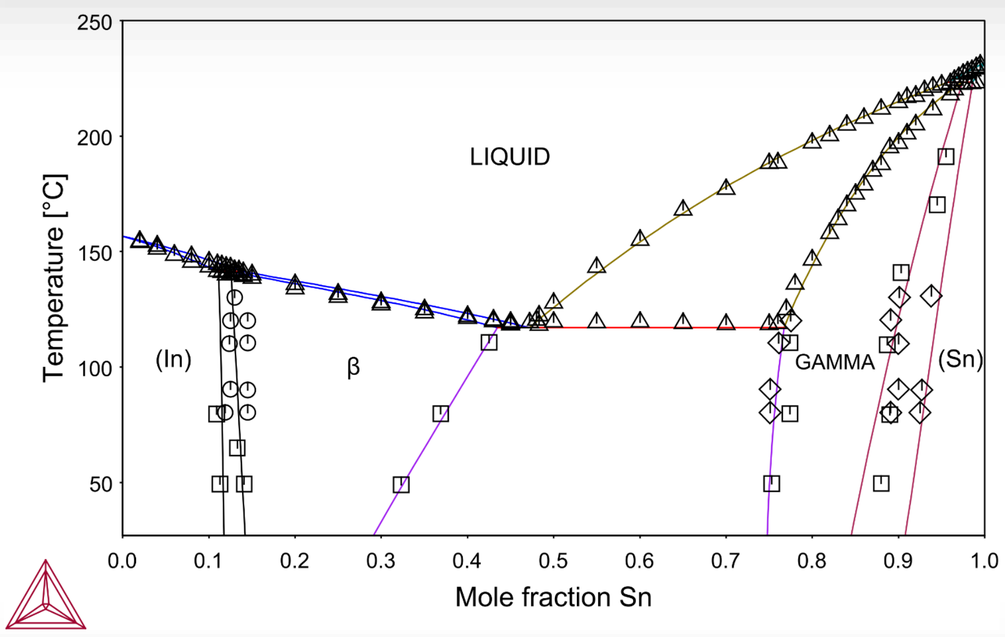
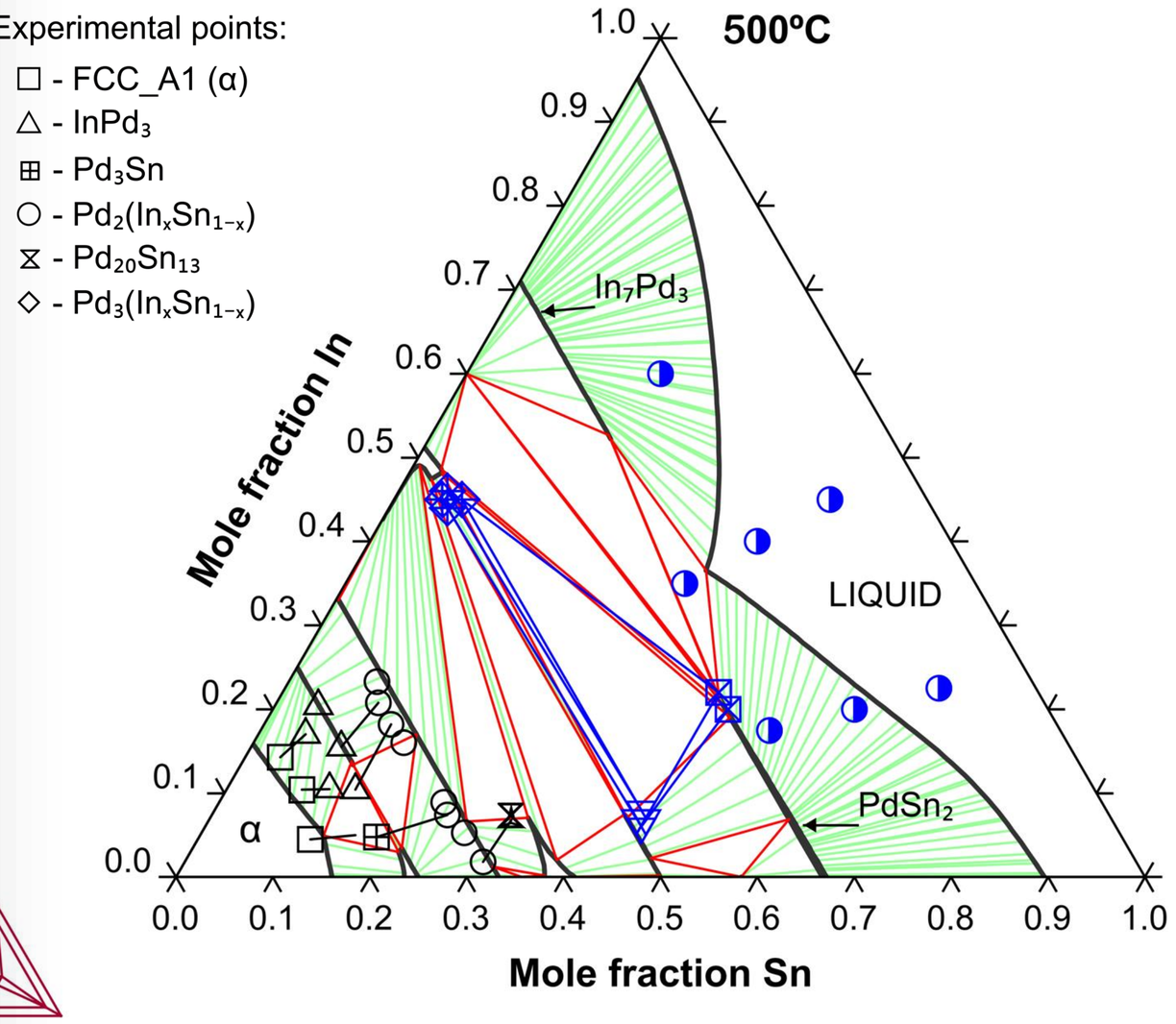


Fig. 1. Calculation results for the In-Sn system.



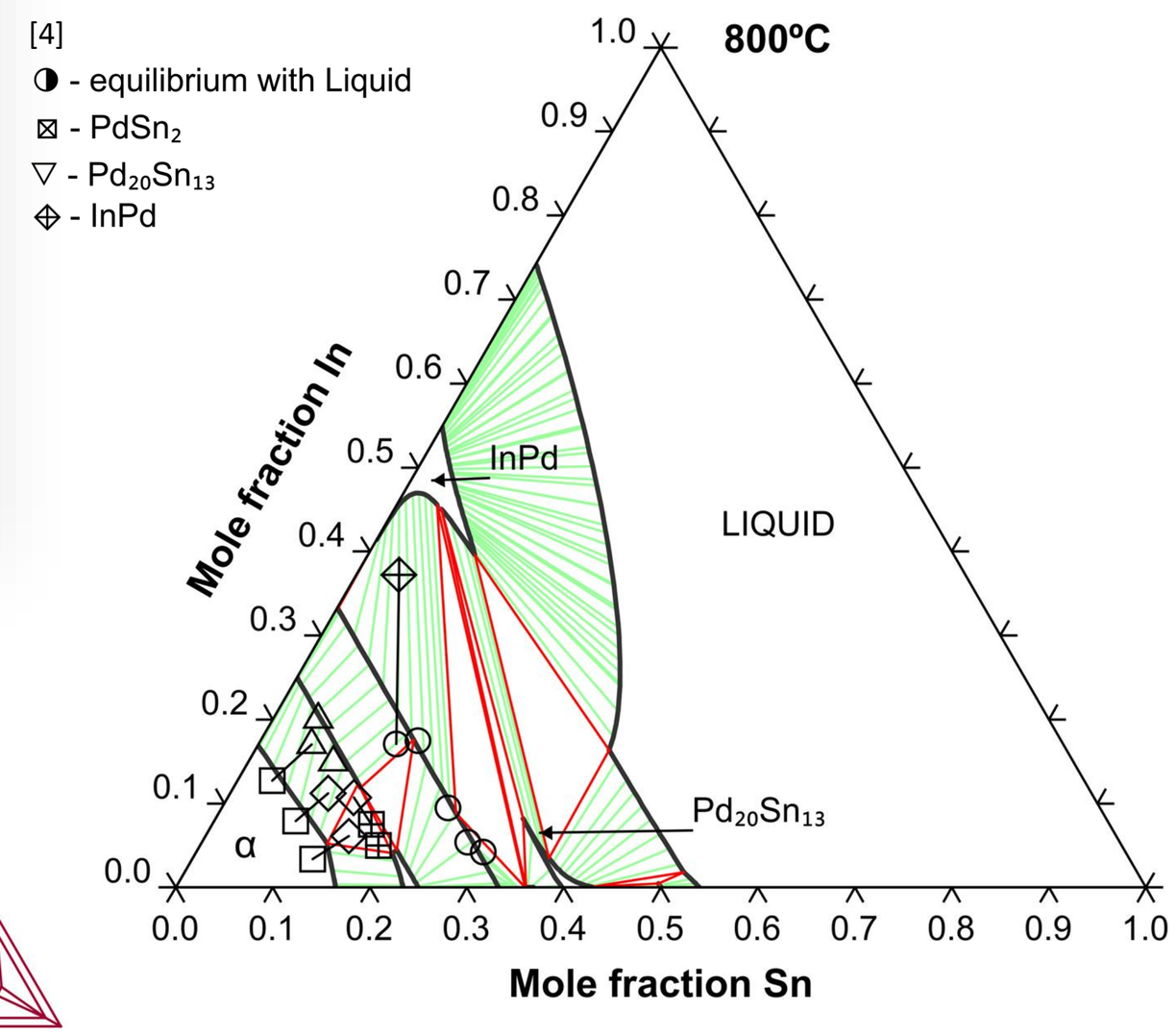


Fig. 2. Calculated isothermal sections of the system In – Pd – Sn at 500 and 800 ° C with superimposed experimental data: black lines and points – this work; blue lines and points – [4].

Conclusions

Phase equilibria in the In-Pd-Sn ternary system are established at 500 and 800 ° C at a palladium content of more than 50 at. %.

Based on the obtained experimental data, a CALPHAD calculation was performed.

References

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