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Thermodynamic re-assessment of Ni-Sn system

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1. introduction

- Within the efforts to replace the traditional leaded solder by more environmentally friendly alloys, Ag-Sn alloys are considered to be the most promising alternative. The intermetallic compounds generated by the solder and the copper substrate will seriously affect the reliability of the solder joints in microelectronic packaging.Ni-Pd coating is usually used as a protective layer to protect chips in microelectronics package.
- The aim of this work is to provide a set of self-consistent thermodynamic parameters for the Ni-Sn system by means of calculation of phase diagrams (CALPHAD) approach. Compared with previous assessments, obvious improvements have been achieved in the present work, especially the enthalpies of mixing of liquid and phase transition temperature between Ni_3Sn_2_LT and Ni_3Sn_LT phase.

2. Thermodynamic modeling

- Solution phases

  Liquid:(Ni,Sn)

  fcc_A1:$(Ni,Sn)_1(Va)_1$

  bct_A5:(Ni,Sn)

- Intermetallic compounds

  Ni_3Sn_HT:$(Ni,Sn)_{0.25}(Ni,Sn)_{0.25}Ni_{0.5}$

  Ni_3Sn_LT:$(Ni,Sn)_{0.75}(Ni,Sn)_{0.25}$

  Ni_3Sn_2_HT:$Ni_{0.33333}(Ni,Sn)_{0.33334}Sn_{0.33333}$

  Ni_3Sn_2_LT:$Sn_{0.2}(Ni,Sn)_{0.4}Ni_{0.4}$

  Ni_3Sn_4:$Ni_{0.25}(Ni,Sn)_{0.25}Sn_{0.5}$

3. Thermodynamic calculation

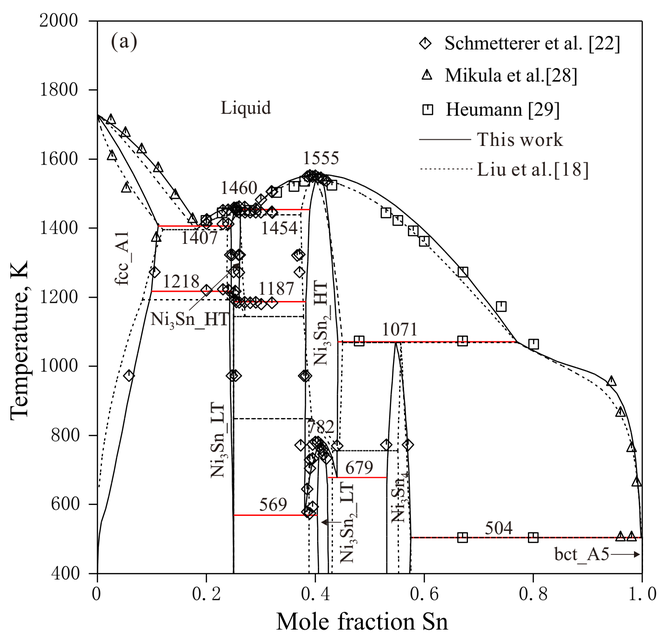

Fig. 1. Calculated Ni–Sn phase diagram with the experimental data from the literatur[22,28,29].

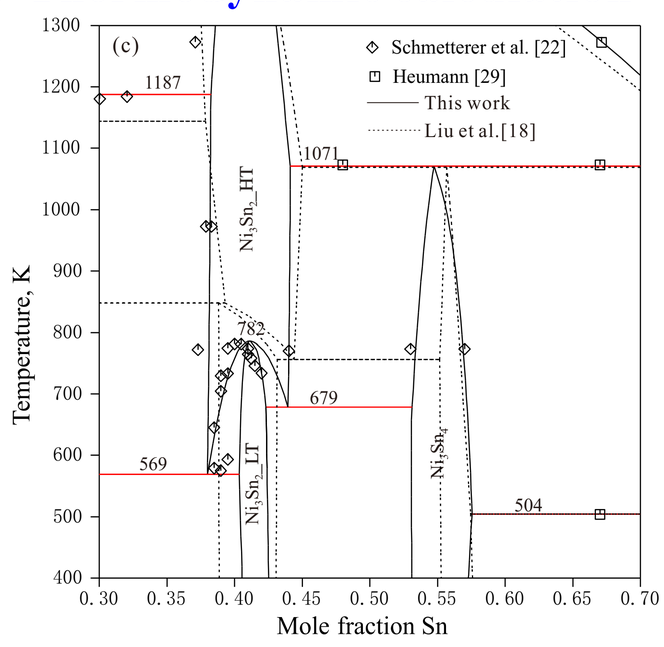

Fig. 2. Calculated 30–70 at.% Sn region along with the experimental data from the literatur[22,29].

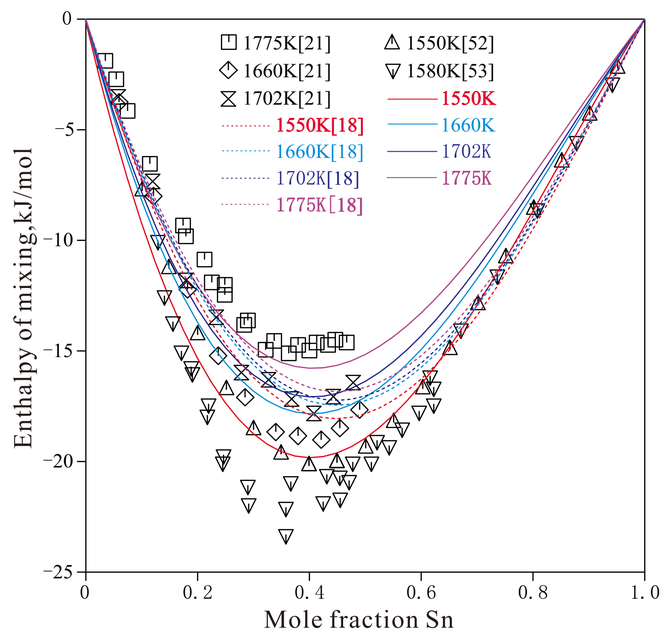

Fig. 3. Calculated enthalpy of mixing of liquid compared with the experimental data [21,52,53] and the calculation results of Liu et al. [18].

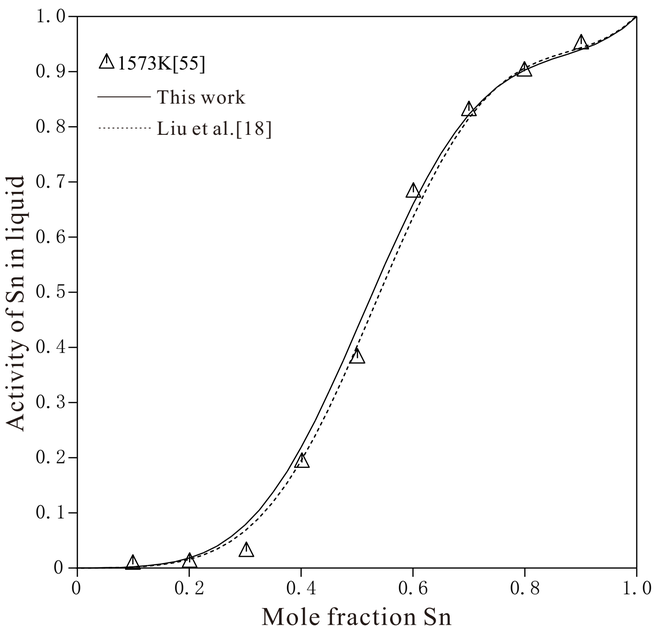

Fig. 4. Calculated activity of Sn in liquid compared with the experimental data [55] and the calculation results of Liu et al. [18].

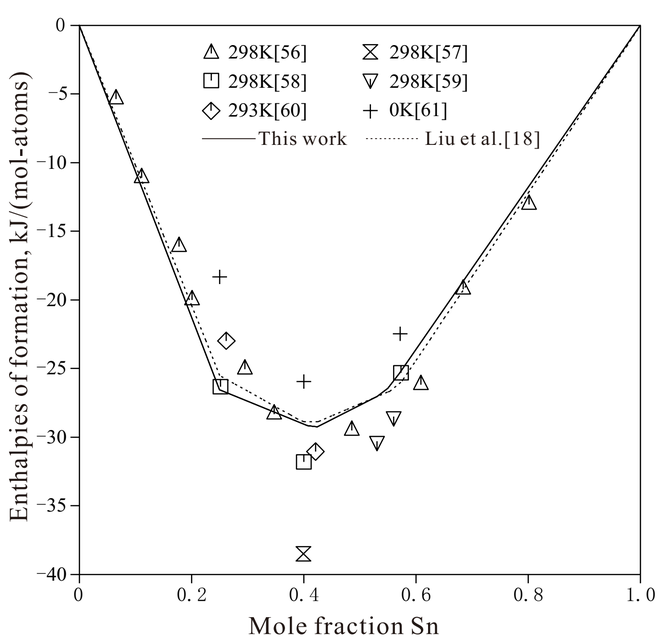

Fig. 5. Calculated enthalpy of formation at 298 K compared with the experimental data [56-61] and the calculation results of Liu et al.[18].

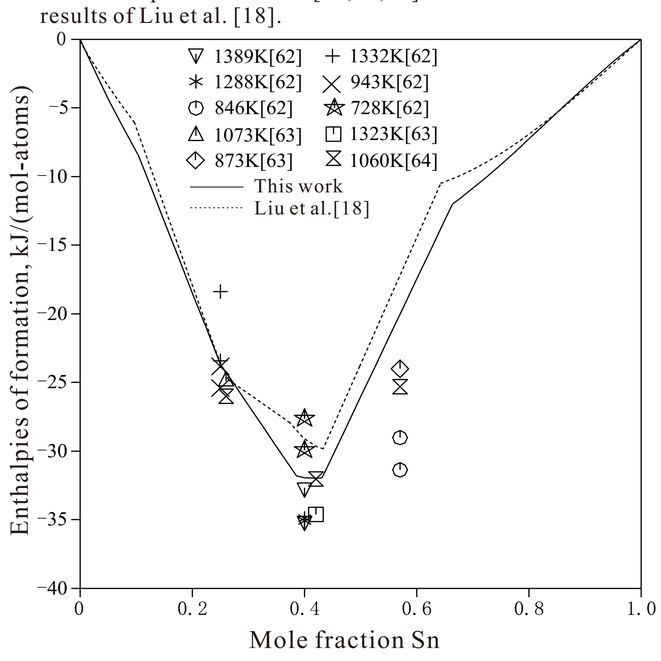

Fig. 6. Calculated enthalpy of formation at 1288 K compared with the experimental data [62-64] and the calculation results of Liu et al.[18].

4. Conclusions

A self-consistent set of thermodynamic parameters was obtained. The present assessment yields a better agreement with the experimental data in comparison with the previous assessments.

Acknowledgement

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