Table 1 Comparison between thermodynamic parameters of the liquid phase [28-31].

	Nakano [28, 29]	Xiong [30]	Tang [31]	Present work
${}^{0}L_{\mathrm{Fe,Zn}}^{\mathrm{Liq.}}$	+ 58088 − 23.665·T	+ 20696.5073	+125613.74 ×exp(− 1.38979·10^{-3}·T)	+ 20116.2
${}^{1}L_{\mathrm{Fe,Zn}}^{\mathrm{Liq.}}$	+ 92219 − 55.584·T	+ 14782.0192 − 8.9768·T	+189615.062 ×exp(− 2.3496·10^{-3}·T)	− 150.285
${}^{2}L_{\mathrm{Fe,Zn}}^{\mathrm{Liq.}}$	+ 13570	− 11266.6992 + 7.3942·T	− 2137.539	− 1561.94
G_$\mathrm{FeZn_{12}}$				− 112799.9 + 141.485·T
Notes	MG at HT appears.	MG at HT was corrected.	MG at HT was corrected using exponential parameters.	Associate solution model was utilized.

* "MG" and "HT" represent "miscibility gap" and "high temperature", respectively.

Table 2 Nominal symbols, stoichiometric ratios, crystal structures, and formula of Gibbs energy models in Zn-Fe binary system.

Phase	Pearson symbol	Space group	Prototype	Formula in the present study
Liquid	-	-	-	(Fe, Zn, $\mathrm{FeZn_{12}}$)
(αFe)	*cI*2	$Im\bar{3}m$	W	$(\mathrm{Fe, Zn})_1(\mathrm{Va})_3$
(γFe)	*cF*4	$Fm\bar{3}m$	Cu	$(\mathrm{Fe, Zn})_1(\mathrm{Va})_1$
Γ-$\mathrm{Fe_4Zn_9}$	*cI*52	$I\bar{4}3m$	$\mathrm{Cu_5Zn_8}$	$(\mathrm{Fe})^{\mathrm{I}}_{0.0667}(\mathrm{Zn})^{\mathrm{II}}_{0.6}(\mathrm{Fe, Zn})^{\mathrm{III}}_{0.3333}$
Γ_1-$\mathrm{Fe_{11}Zn_{40}}$	*cF*408	$F\bar{4}3m$	$\mathrm{Fe_{11}Zn_{40}}$	$(\mathrm{Fe})^{\mathrm{I}}_{0.0769}(\mathrm{Zn})^{\mathrm{II}}_{0.6923}(\mathrm{Fe, Zn})^{\mathrm{III}}_{0.2308}$
δ_{1k}-$\mathrm{FeZn_7}$	Three times as large as that of δ_{1p}			$(\mathrm{Fe})^{\mathrm{I}}_{0.0714}(\mathrm{Zn})^{\mathrm{II}}_{0.7143}(\mathrm{Fe, Zn})^{\mathrm{III}}_{0.2143}$
δ_{1p}-$\mathrm{Fe_{13}Zn_{126}}$	*hP*555	$P6_3mc$	$\mathrm{FeZn_{10}}$	$(\mathrm{Fe})^{\mathrm{I}}_{0.0714}(\mathrm{Zn})^{\mathrm{II}}_{0.7143}(\mathrm{Fe, Zn})^{\mathrm{III}}_{0.2143}$
ζ-$\mathrm{FeZn_{13}}$	*mC*28	*C*2/m	$\mathrm{CoZn_{13}}$	$(\mathrm{Fe})^{\mathrm{I}}_{0.0667}(\mathrm{Zn})^{\mathrm{II}}_{0.7333}(\mathrm{Fe, Zn})^{\mathrm{III}}_{0.2}$
(ηZn)	*hP*2	$P6_3/mmc$	Mg	$(\mathrm{Fe, Zn, FeZn_{12}})_1(\mathrm{Va})_{0.5}$

Table 3 Thermodynamic and magnetic parameters of the Fe-Zn system evaluated in this study. Gibbs energy parameters of pure elements are taken from reference [43] and the magnetic properties of disordered solution phases, γFe (*A*1) and αFe (*A*2), are from reference [28].

Thermodynamic parameters [J/mol] and magnetic parameters [K], [μ_B]
Liquid : (Fe, Zn, $FeZn_{12}$)
${}^0L^{L}_{Fe,Zn} = +20116.2$, ${}^1L^{L}_{Fe,Zn} = -150.285$, ${}^2L^{L}_{Fe,Ni} = -1561.94$ $L^{L}_{Fe,Fe_1Zn_{12}} = L^{L}_{Zn,Fe_1Zn_{12}} = 0$ $G^{L}_{Fe_1Zn_{12}} = -8676.917 + 10.8835\,T + 0.0769\,G^{L}_{Fe} + 0.9231\,G^{L}_{Zn}$
αFe (*A*2) : $(Fe, Zn)_1\ (Va)_3$
${}^0L^{A2}_{Fe,Zn} = -8169.109 + 16.6657\,T$, ${}^1L^{A2}_{Fe,Zn} = +13656.92 - 13.9237\,T$, ${}^2L^{A2}_{Fe,Zn} = +4485.963$ $T_C{}^{A2} = 1043x_{Fe} + 504.3x_{Fe}x_{Zn}$, $\beta^{A2} = 2.22x_{Fe}$
γFe (*A*1) : $(Fe, Zn)_1\ (Va)_1$
${}^0L^{A1}_{Fe,Zn} = +12487.70$, ${}^1L^{A1}_{Fe,Zn} = +1441.752$ $T_C{}^{A1} = -201x_{Fe}$, $\beta^{A1} = -2.1x_{Fe}$
ηZn (*A*3) : $(Fe, Zn, FeZn_{12})_1\ (Va)_{0.5}$
${}^0L^{A3}_{Fe,Zn} = +1500 + 5\,T$, $L^{A3}_{Fe,Fe_1Zn_{12}} = L^{A3}_{Zn,Fe_1Zn_{12}} = 0$ $G^{A3}_{Fe_1Zn_{12}} = -284.615 + 0.0769\,G^{A3}_{Fe} + 0.9231\,G^{A3}_{Zn}$
Γ-Fe_4Zn_9 : $(Fe)^{I}_{0.0667}(Zn)^{II}_{0.6}(Fe, Zn)^{III}_{0.3333}$
$G^{\Gamma}_{Fe:Zn:Fe} = -4003.232 + 0.7346\,T + 0.4\,{}^\circ G^{A2}_{Fe} + 0.6\,{}^\circ G^{A3}_{Zn}$ $G^{\Gamma}_{Fe:Zn:Zn} = +2515.325 - 4.3415\,T + 0.0667\,{}^\circ G^{A2}_{Fe} + 0.9333\,{}^\circ G^{A3}_{Zn}$ $L^{\Gamma}_{Fe:Zn:Fe,Zn} = -18228.68 + 19.9038\,T$
Γ_1-$Fe_{11}Zn_{40}$: $(Fe)^{I}_{0.0769}(Zn)^{II}_{0.6923}(Fe, Zn)^{III}_{0.2308}$
$G^{\Gamma 1}_{Fe:Zn:Fe} = -5485.973 + 2.5583\,T + 0.3077\,{}^\circ G^{A2}_{Fe} + 0.6923\,{}^\circ G^{A3}_{Zn}$ $G^{\Gamma 1}_{Fe:Zn:Zn} = +4399.436 - 6.3696\,T + 0.0769\,{}^\circ G^{A2}_{Fe} + 0.9231\,{}^\circ G^{A3}_{Zn}$ $L^{\Gamma 1}_{Fe:Zn:Fe,Zn} = -20229.49 + 20.8641\,T$
δ_{1k}-$FeZn_7$: $(Fe)^{I}_{0.0714}(Zn)^{II}_{0.7143}(Fe, Zn)^{III}_{0.2143}$
$G^{\delta 1k}_{Fe:Zn:Fe} = -6786.998 + 4\,T + 0.2857\,{}^\circ G^{A2}_{Fe} + 0.7143\,{}^\circ G^{A3}_{Zn}$ $G^{\delta 1k}_{Fe:Zn:Zn} = -2432.079 - 0.2861\,T + 0.0714\,{}^\circ G^{A2}_{Fe} + 0.9286\,{}^\circ G^{A3}_{Zn}$ $L^{\delta 1k}_{Fe:Zn:Fe,Zn} = -1233.705 + 2.4548\,T$
δ_{1p}-$Fe_{13}Zn_{126}$: $(Fe)^{I}_{0.0714}(Zn)^{II}_{0.7143}(Fe, Zn)^{III}_{0.2143}$
$G^{\delta 1p}_{Fe:Zn:Fe} = -6646.204 + 4\,T + 0.2857\,{}^\circ G^{A2}_{Fe} + 0.7143\,{}^\circ G^{A3}_{Zn}$ $G^{\delta 1p}_{Fe:Zn:Zn} = -2088.477 - 0.79\,T + 0.0714\,{}^\circ G^{A2}_{Fe} + 0.9286\,{}^\circ G^{A3}_{Zn}$ $L^{\delta 1p}_{Fe:Zn:Fe,Zn} = -1300 + 3\,T$
ζ-$FeZn_{13}$: $(Fe)^{I}_{0.0667}(Zn)^{II}_{0.7333}(Fe, Zn)^{III}_{0.2}$
$G^{\zeta}_{Fe:Zn:Fe} = +46222.16 + 3.9874\,T + 0.2667\,{}^\circ G^{A2}_{Fe} + 0.7333\,{}^\circ G^{A3}_{Zn}$ $G^{\zeta}_{Fe:Zn:Zn} = -2699.545 + 0.1895\,T + 0.0667\,{}^\circ G^{A2}_{Fe} + 0.9333\,{}^\circ G^{A3}_{Zn}$ $L^{\zeta}_{Fe:Zn:Fe,Zn} = -54547.42$