TCAL5: TCS Al-based Alloy Database

Database name:	TCS Al-based Alloys Database	*Database acronym:*	TCAL
Database owner:	Thermo-Calc Software AB	*Database version:*	5.1

TCAL5 is a thermodynamic database for Al-based alloys for use with Thermo-Calc and the add-on Diffusion Module (DICTRA) and/or Precipitation Module (TC-PRISMA). TCAL5 is based on the critical evaluation of binary, ternary and important higher-order systems which enables predictions to be made for multi-component systems and alloys of industrial importance.

A hybrid approach of experiments, first-principles calculations and CALPHAD modeling has been used to obtain thermodynamic descriptions of the constituent binary and ternary systems over the whole composition and temperature ranges. The database has been validated where possible against higher-order systems and is the result of a long-term collaboration with academia that has involved extensive experimental work, theoretical calculations and critical assessments of the published literature. The database has been developed in a 35-element framework:

Al	Ag	B	Be	Bi	C	Ca	Cd	Ce
Co	Cr	Cu	Er	Fe	Ga	Ge	H	Hf
In	K	La	Li	Mg	Mn	Na	Ni	Pb
Sc	Si	Sn	Sr	Ti	V	Zn	Zr	

In total, 258 of the binary systems in this 35-element framework have been assessed, mostly to their full range of composition, and can be calculated with the BINARY Module in Thermo-Calc. TCAL also contains assessments of 87 ternaries, and these can be calculated with the TERNARY Module in Thermo-Calc. Many quaternaries with Al as one element have also been assessed.

TCAL contains nearly 600 solution and intermetallic phases in total. The GAS phase is rejected by default when retrieving the data from the database. When this phase is required for a calculation, it has to be manually restored. Phase diagrams of assessed binary and ternary systems can be conducted using the BINARY and TERNARY modules, respectively. The complete list of phases is given at the end of this document. First there is a list of all phases and then a detailed description of their models, e.g. number of sublattices and constituents on each sublattice.

TCAL includes nearly all stable phases in the assessed systems and most important metastable phases (or precipitates) that may form in as-cast and aged Al-based alloys. 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 aluminum alloys to be able to predict the phase formation, phase fractions and phase compositions or to calculate the driving force of forming a phase. Note that the extrapolation to higher-order systems might not be valid beyond the Al-rich region. The database can also be used for predicting solidification behaviour of Al-alloys with the SCHEIL_GULLIVER module in Thermo-Calc and simulating multi-particle precipitation during aging treatment with the add-on Precipitation Module (TC-PRISMA).

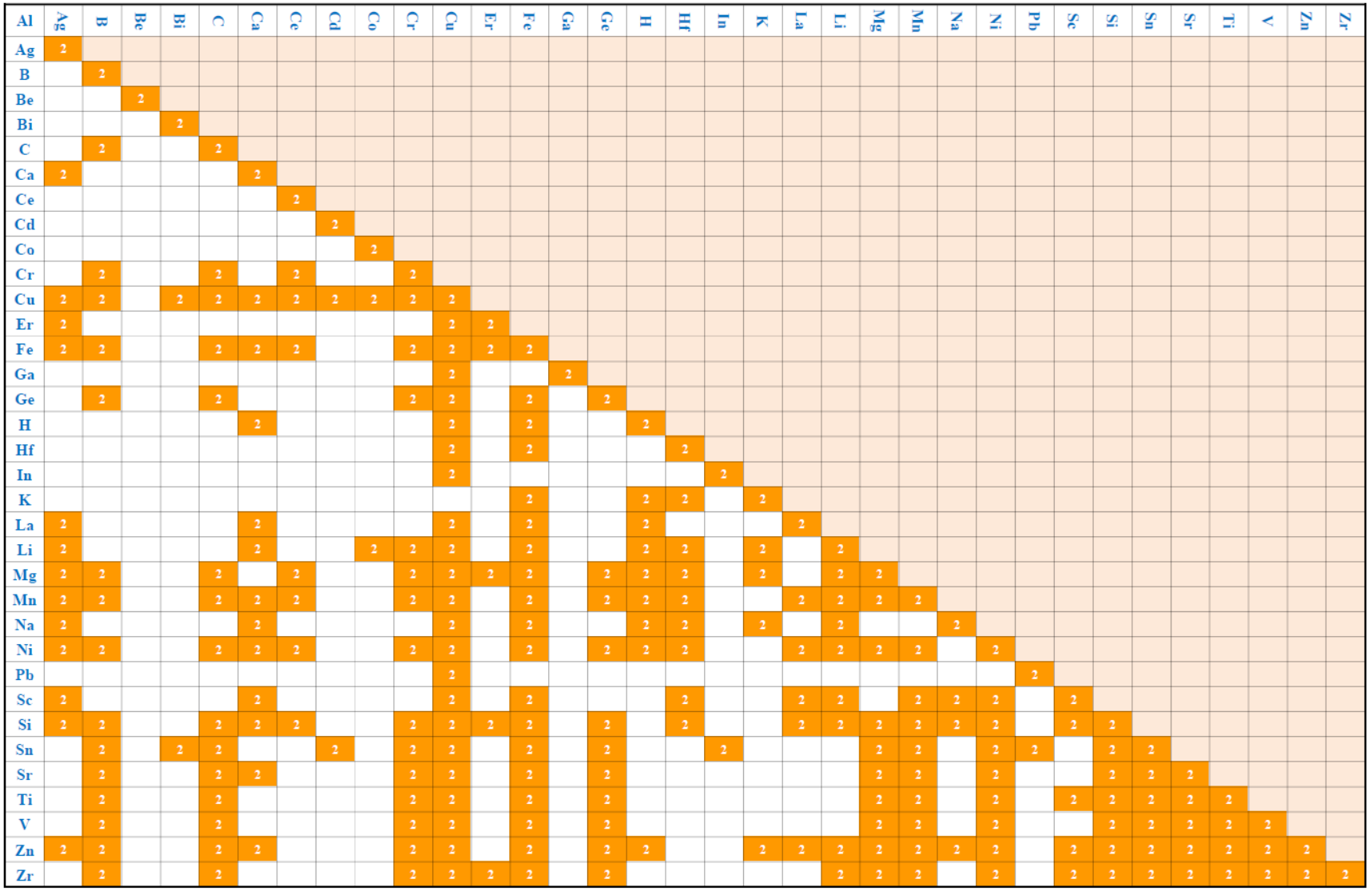
Some ordered compounds with the structure of $L1_2$ or B2 were modeled as stoichiometric phases, and named as L12_FCC and B2_BCC, respectively. The $L1_2$-type precipitate that forms in Er, Li and Sc containing aluminum alloys was modeled as Al3X, and its solubility of Ti, Zr and Mg was described. In general, however, the ordered B2 and $L1_2$ phases, together with bcc_A2 and fcc_A1, respectively, have

been modeled with the so-called partition model, which describes an ordered phase and its disordered counterpart using a single Gibbs energy curve. This type of description is of particular importance to be able to predict second order transformations between a disordered phase and its ordered structures. Also note that there may be several possible composition sets for the phases named FCC_L12 and BCC_B2, due to the co-existence of disordered and ordered structures or the presence of miscibility gap.

Database Revision History

 If you are interested in the revision history for this database, the information is available in the online help (from Thermo-Calc go to **Help>Online Help**) or in the release notes on our website.

Assessed Binary Systems in Full Range of Composition and Temperature



	Al	Ag	B	Be	Bi	C	Ca	Ce	Cd	Co	Cr	Cu	Er	Fe	Ga	Ge	H	Hf	In	K	La	Li	Mg	Mn	Na	Ni	Pb	Sc	Si	Sn	Sr	Ti	V	Zn	Zr
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Er	2	2										2	2																						
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K														2			2	2		2																
La	2	2					2					2		2			2				2															
Li	2	2					2			2	2	2		2			2	2		2		2													
Mg	2	2	2			2		2			2	2	2	2		2	2	2		2		2	2												
Mn	2	2	2			2	2	2			2	2		2		2	2	2			2	2	2	2											
Na	2	2					2					2		2			2	2		2		2			2										
Ni	2	2	2			2	2	2			2	2		2		2	2	2			2	2	2	2		2									
Pb												2															2								
Sc	2	2					2					2		2				2			2	2		2	2	2		2							
Si	2	2	2			2	2	2			2	2	2	2		2		2			2	2	2	2	2	2		2	2						
Sn			2		2	2			2		2	2		2		2			2				2	2		2	2		2	2					
Sr			2			2	2				2	2		2		2							2	2		2			2	2	2				
Ti			2			2					2	2		2		2							2	2		2		2	2	2	2	2			
V			2			2					2	2		2		2							2	2		2			2	2	2	2	2		
Zn	2	2	2			2	2				2	2		2		2	2			2	2	2	2	2	2	2		2	2	2	2	2	2	2	
Zr			2			2					2	2	2	2		2						2	2	2		2		2	2	2	2	2	2	2	2

Assessed Ternary Systems: Mostly in Full Compositional Ranges

Al-Ag-Cu	Al-Bi-Sn	Al-C-Si	Al-Cd-Sn
Al-Ce-Cr	Al-Ce-Cu	Al-Ce-Fe	Al-Ce-Mg
Al-Ce-Mn	Al-Ce-Ni	Al-Ce-Si	Al-Cr-Si
Al-Cr-Sn	Al-Cu-Er	Al-Cu-Fe	Al-Cu-Li
Al-Cu-Mg	Al-Cu-Mn	Al-Cu-Ni	Al-Cu-Sc
Al-Cu-Si	Al-Cu-Sn	Al-Cu-Zn	Al-Er-Fe
Al-Er-Mg	Al-Fe-Mg	Al-Fe-Mn	Al-Fe-Ni
Al-Fe-Si	Al-Fe-Zn	Al-In-Sn	Al-Li-Mg
Al-Li-Si	Al-Li-Zr	Al-Mg-Mn	Al-Mg-Ni
Al-Mg-Si	Al-Mg-Zn	Al-Mn-Ni	Al-Mn-Si
Al-Mn-Zn	Al-Ni-Si	Al-Ni-Zn	Al-Sc-Si
Al-Sc-Ti	Al-Sc-Zr	Al-Si-Ti	Al-Si-Zn
Al-Sn-Pb	Al-Sn-Si	Al-Sn-Zn	Cu-Fe-Mg
Cu-Fe-Mn	Cu-Fe-Ni	Cu-Fe-Si	Cu-Fe-Zn
Cu-Li-Mg	Cu-Mg-Mn	Cu-Mg-Ni	Cu-Mg-Si
Cu-Mg-Zn	Cu-Mn-Ni	Cu-Mn-Si	Cu-Mn-Zn
Cu-Ni-Si	Cu-Ni-Zn	Cu-Si-Zn	Fe-Mg-Mn
Fe-Mg-Ni	Fe-Mg-Si	Fe-Mg-Zn	Fe-Mn-Ni
Fe-Mn-Si	Fe-Mn-Zn	Fe-Ni-Si	Fe-Ni-Zn
Fe-Si-Zn	Mg-Mn-Ni	Mg-Mn-Si	Mg-Mn-Zn
Mg-Ni-Si	Mg-Ni-Zn	Mg-Si-Zn	Mn-Ni-Si
Mn-Ni-Zn	Mn-Si-Zn	Ni-Si-Zn	

Assessed Quaternary Systems

Al-Cu-Mg-Zn	Al-Cu-Mg-Si	Al-Fe-Mn-Si	Al-Cu-Fe-Mn
Al-Cu-Fe-Ni	Al-Cu-Mg-Ni	Al-Cu-Mn-Si	Al-Cu-Ni-Si
Al-Fe-Mg-Mn	Al-Fe-Mg-Si	Al-Fe-Ni-Si	Al-Mg-Mn-Si

TCAL Calculation Examples

Note: Phase diagrams shown in this document have been calculated with various versions of the TCAL database, so small differences might be observed if they are recalculated with TCAL5. For the systems, which have been considerably or significantly improved, however, their phase diagrams should have already been updated.

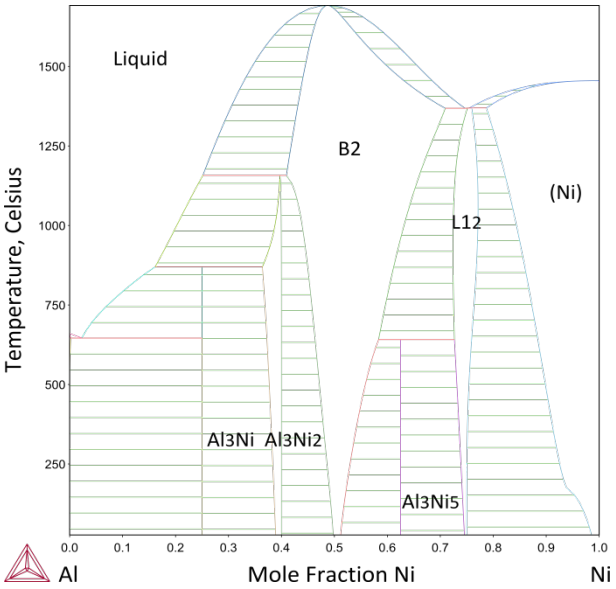

Fig.1: Calculated Al-Ni phase diagram [Ansara et al., 1997].

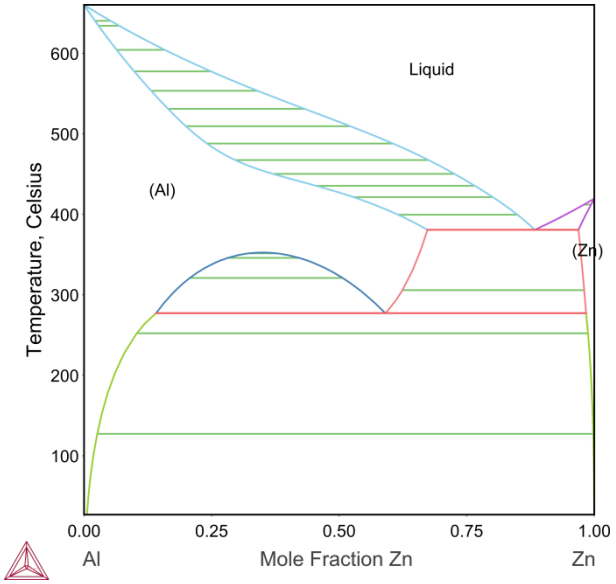

Fig.2: Calculated Al-Zn phase diagram [an Mey, 1993].

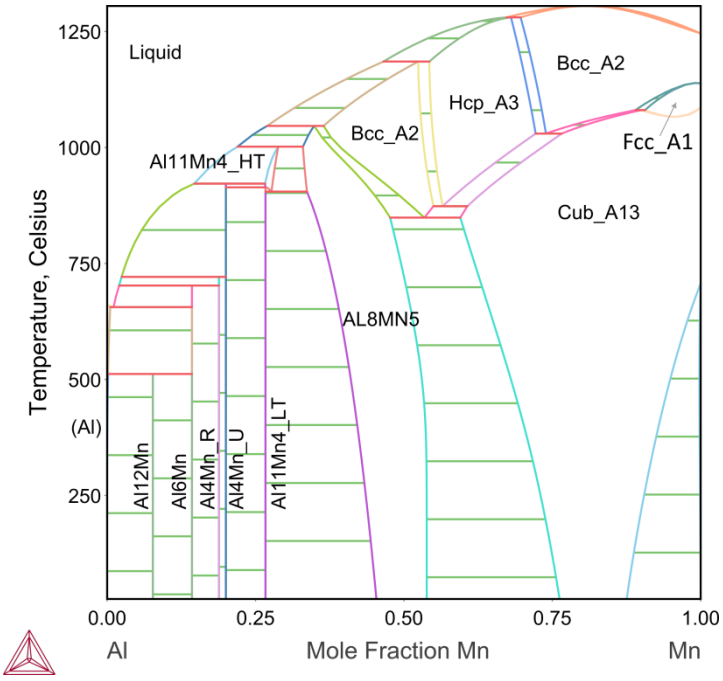

Fig.3: Calculated Al-Mn phase diagram [Du et al, 2007].

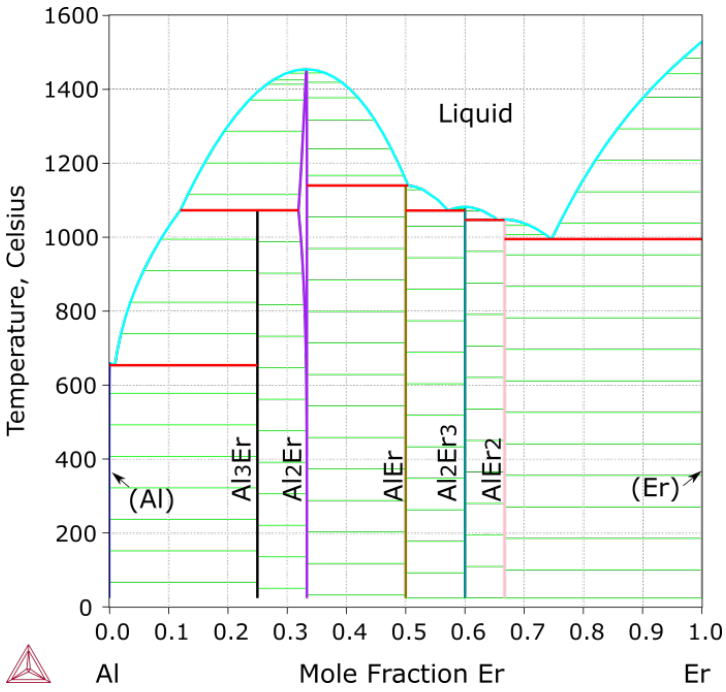

Fig.4: Calculated Al-Er phase diagram, where the Er solubility in (Al) was evaluated [Chen, 2017a].

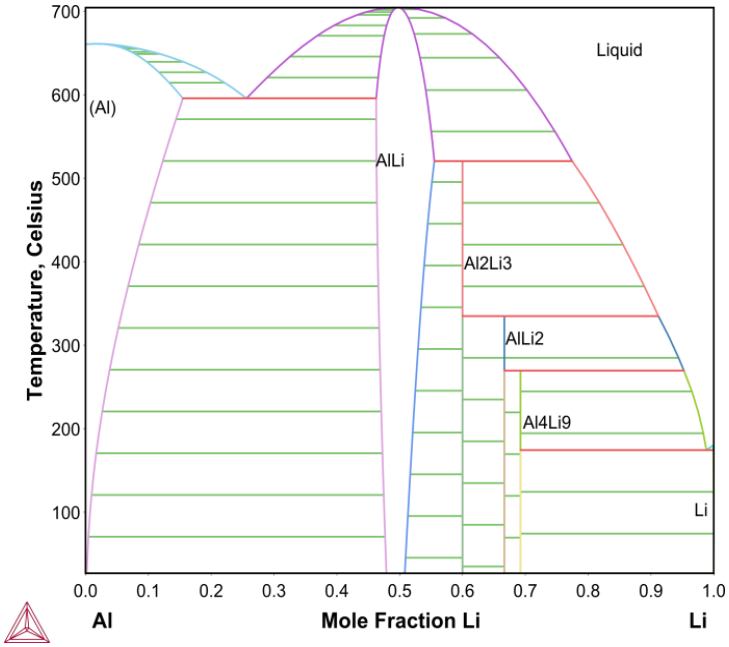

Fig.5: Calculated Al-Li phase diagram [Saunders, 1989 and Chen, 2012/2017b].

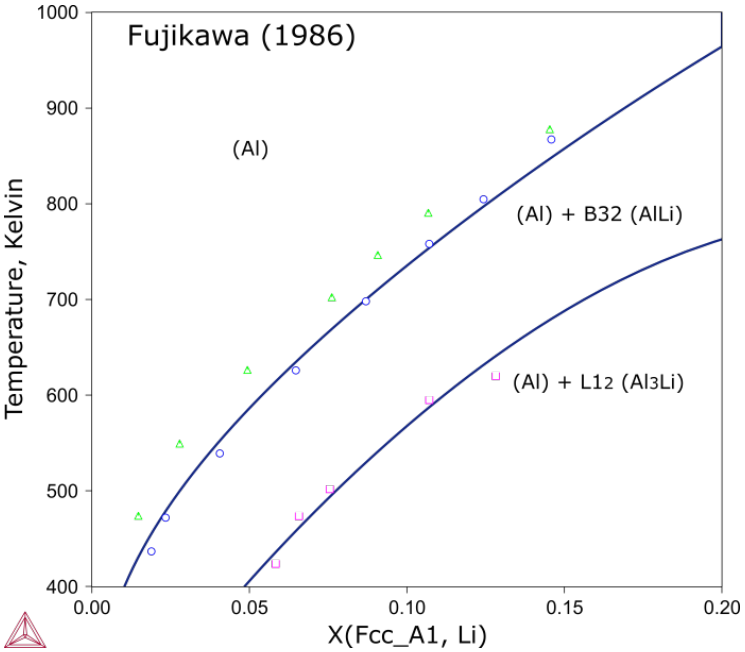

Fig.6: Calculated (Al) solvi in the Al-Li system [Saunders, 1989 and Chen, 2012/2017b], in comparison with the data from Fujikawa [1986].

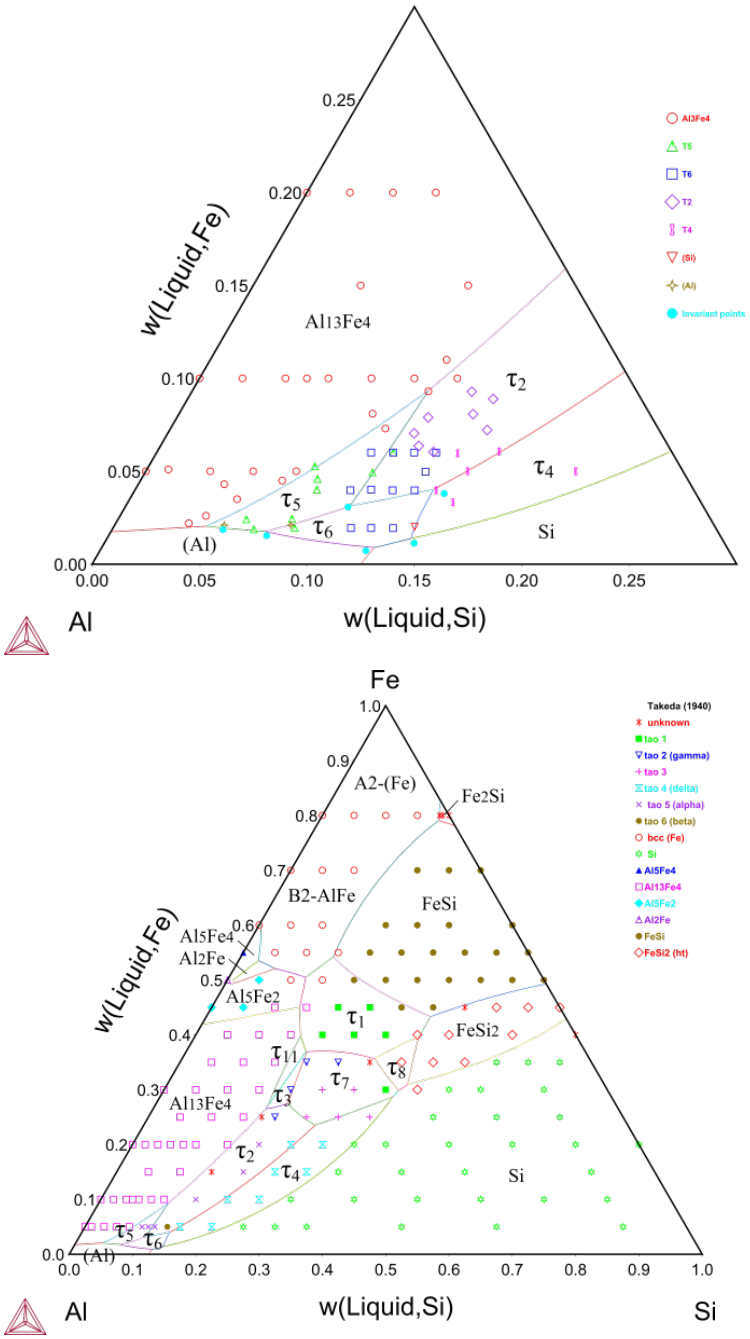

Fig.7: Calculated Al-Fe-Si liquidus projection (τ_5: α-AlFeSi; τ_6: β-AlFeSi), (a) in the Al-rich corner The invariant points are from Pontevichi et al. [2004] and Bosselet et al [2004]. The remaining data from Takeda and Mutuzaki [1940], Munson [1967] and Zakharov et al. [1988]; (b) over the entire compositional range, with the data from Takeda and Mutuzaki [1940].

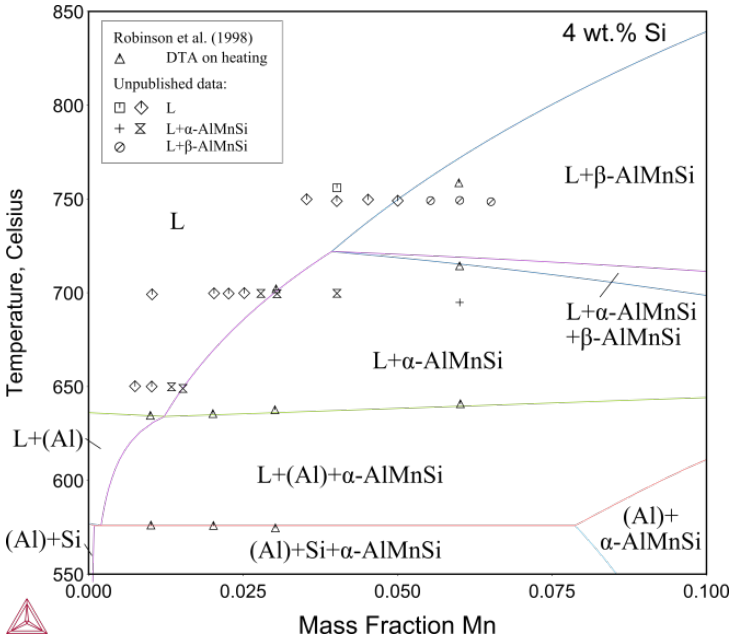

Fig.8: Al-Mn-Si vertical section at 4 wt. % Si (β-AlMnSi: τ_8; α-AlMnSi: τ_9) [Chen et al, 2014].

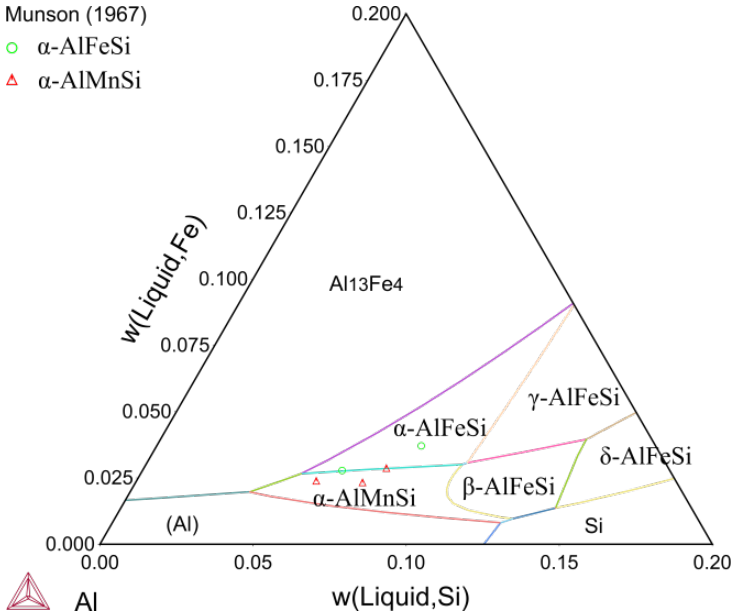

Fig.9: Al-Fe-Mn-Si liquidus surface at 0.3 wt. % Mn. (α-AlFeSi: τ_5; β-AlFeSi: τ_6; γ-AlFeSi: τ_2; δ-AlFeSi: τ_4; α-AlMnSi: τ_9) [Chen et al, 2014a].

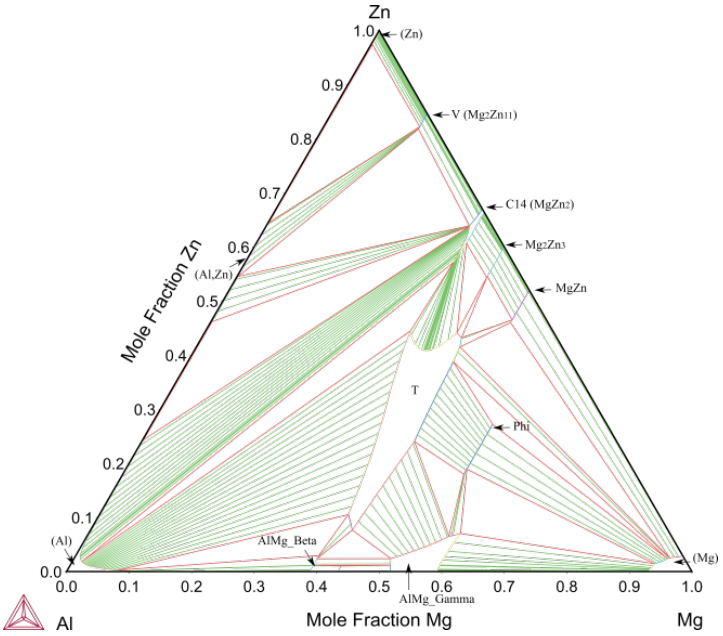

Fig.10: Isothermal section of Al-Mg-Zn at 335 ℃ [Liang et al., 1998].

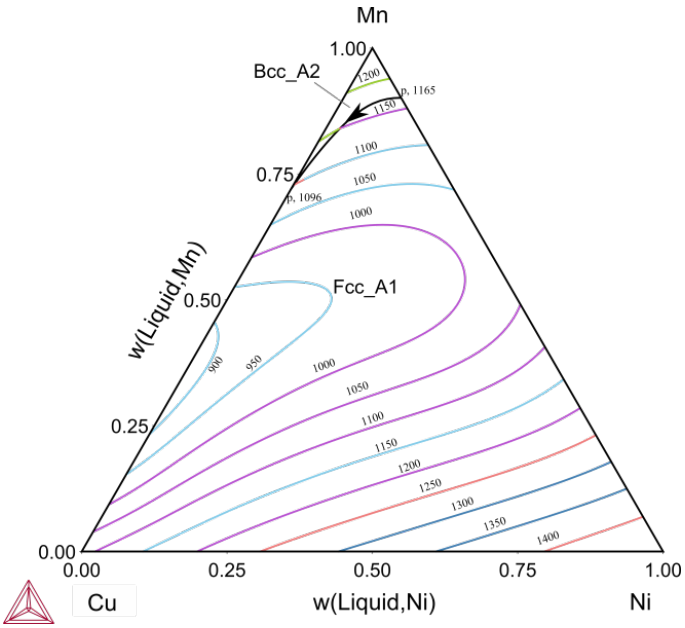

Fig.11: Liquidus projection with isothermal lines in the Cu–Mn–Ni system [Sun et al., 2009].

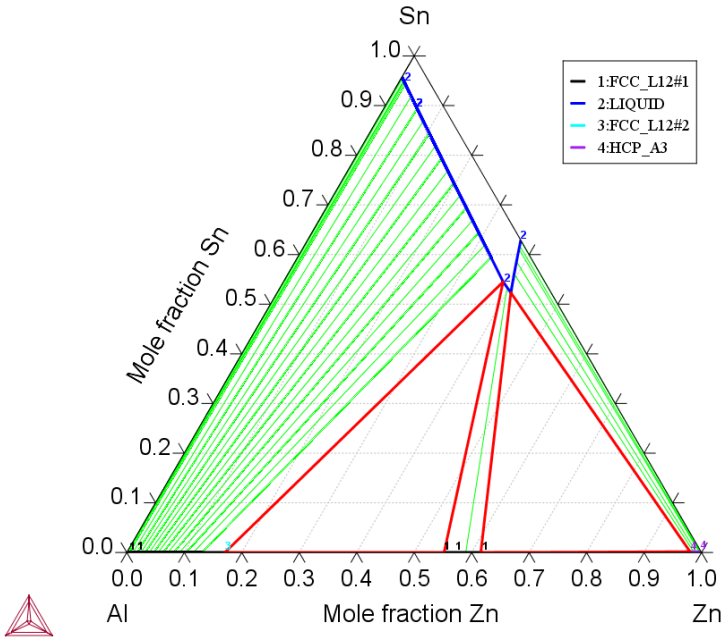

Fig.12: Al-Sn-Zn isothermal section at 300°C [Chen, 2017c].

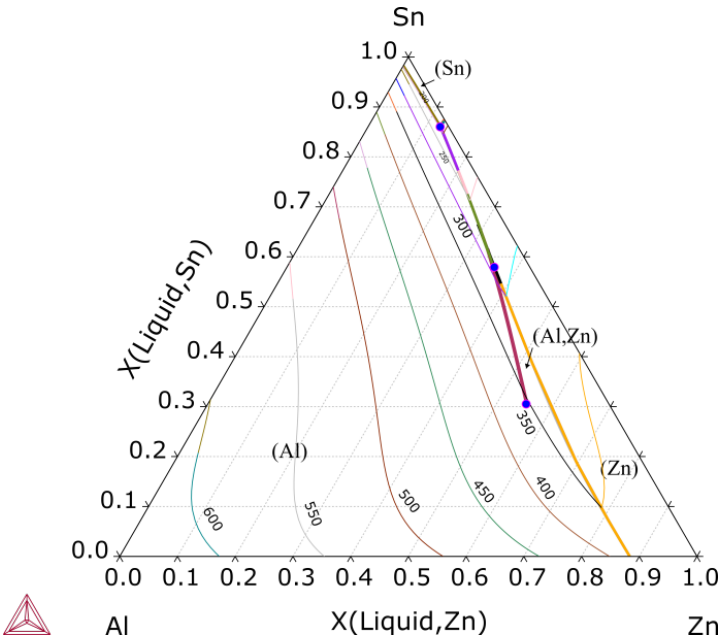

Fig.13: Al-Sn-Zn Liquidus surface projection with isotherms [Chen, 2017c].

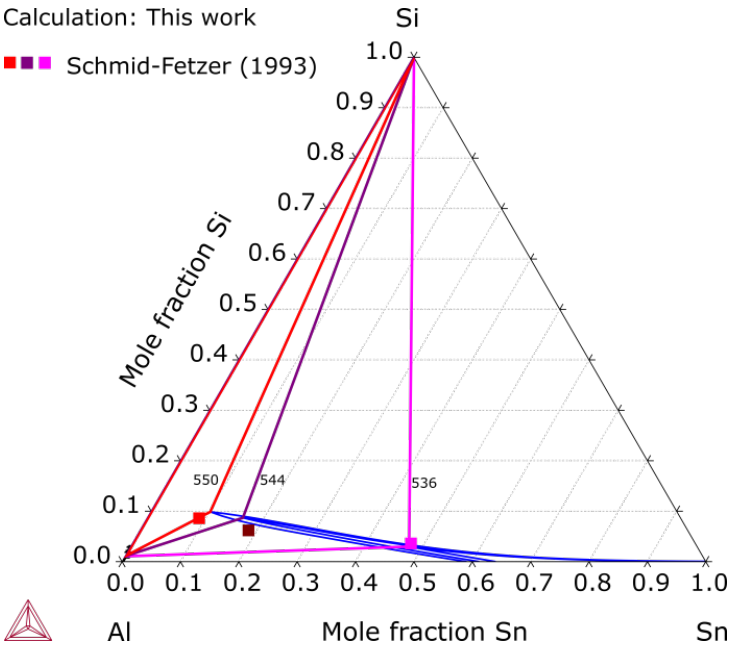

Fig.14: Calculated Al-Si-Sn isothermal sections at 536 °C, 544 °C and 550 °C [Chen, 2017c], with data read from Schmid-Fetzer [1993].

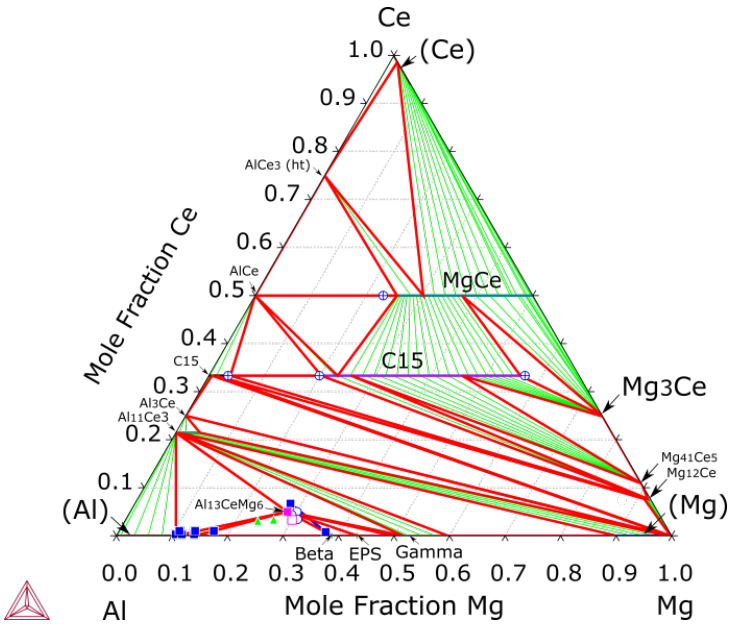

Fig.15: Al-Ce-Mg isothermal section at 400 °C [Chen, 2017d].

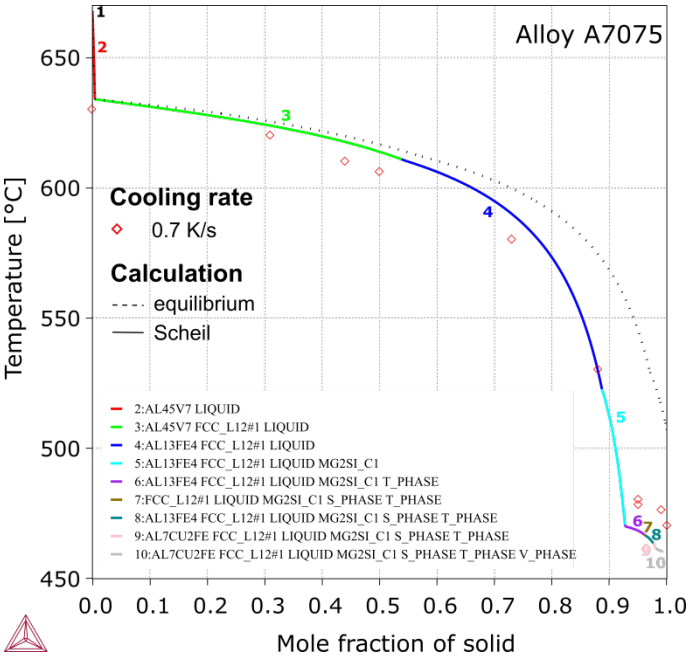

Fig.16: Equilibrium solidification and Scheil solidification simulations of alloy AA7075, compared with experimental results [Backerud, et al., 1990]. (Al), $Al_{13}Fe_4$, Mg_2Si, T-Phase and V-Phase ($MgZn_2$) are found in the microstructure as predicted from the calculation. $Al_{45}Cr_7$ forms primarily as a Cr-bearing phase, which may have been overlooked in experimental investigation due to its small amount. S-Phase was shown at the late stage of the Scheil solidification and its amount is small. Al_2Cu was experimentally observed but not shown in the calculation.

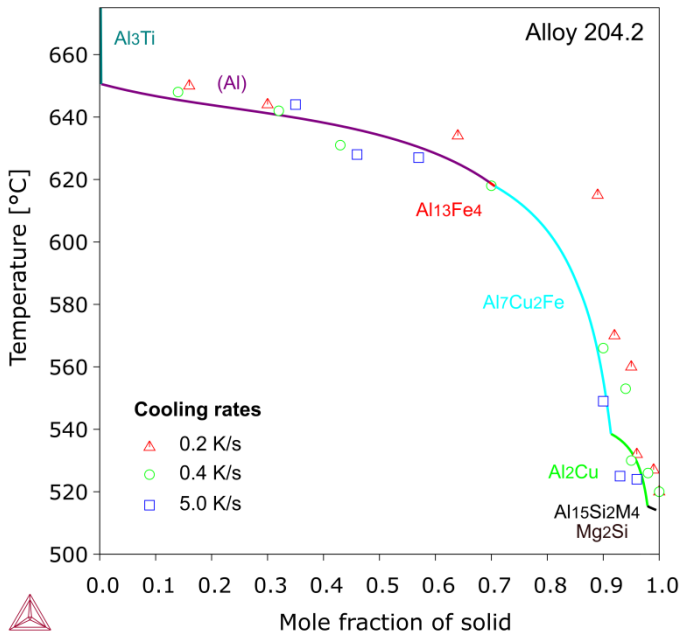

Fig.17: Scheil solidification simulation of foundry alloy 204.2 (Al-$Si_{0.08}Fe_{0.20}Cu_{4.40}Mn_{0.02}Mg_{0.22}Ti_{0.22}$, wt.%), compared with DTA experimental results [Backerud, et al., 1990]. The formation of (Al), $Al_{13}Fe_4$, $Al_6Mn(Cu,Fe)$, Al_7Cu_2Fe and Al_2Cu was reproduced in the Scheil simulation. Al_3Ti appeared as the primary phase due to the Ti addition.

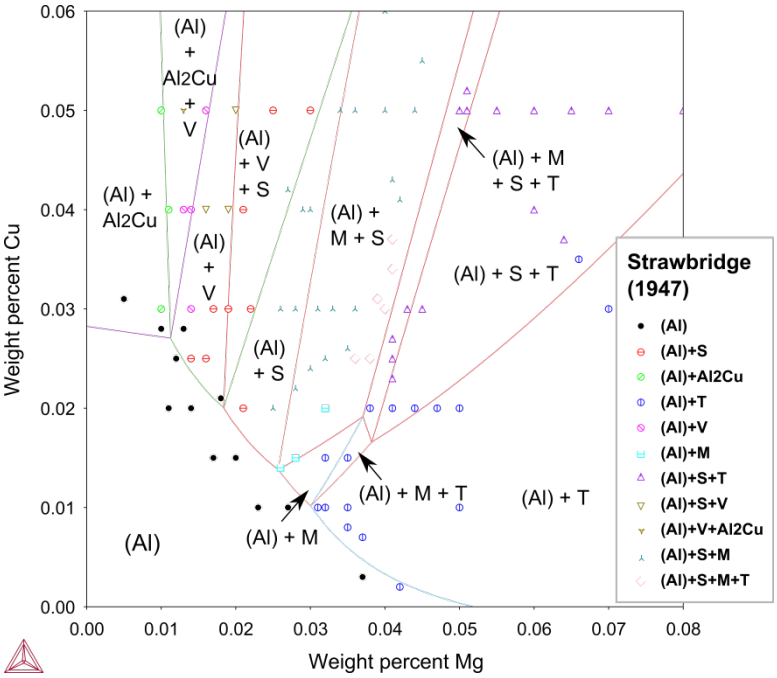

Fig.18: Calculated isothermal sections of the Al-Cu-Mg-Zn system at 460℃: at 8 wt. % Zn [Chen, 2012b] (experimental data are from Strawbridge et al.[1947]).

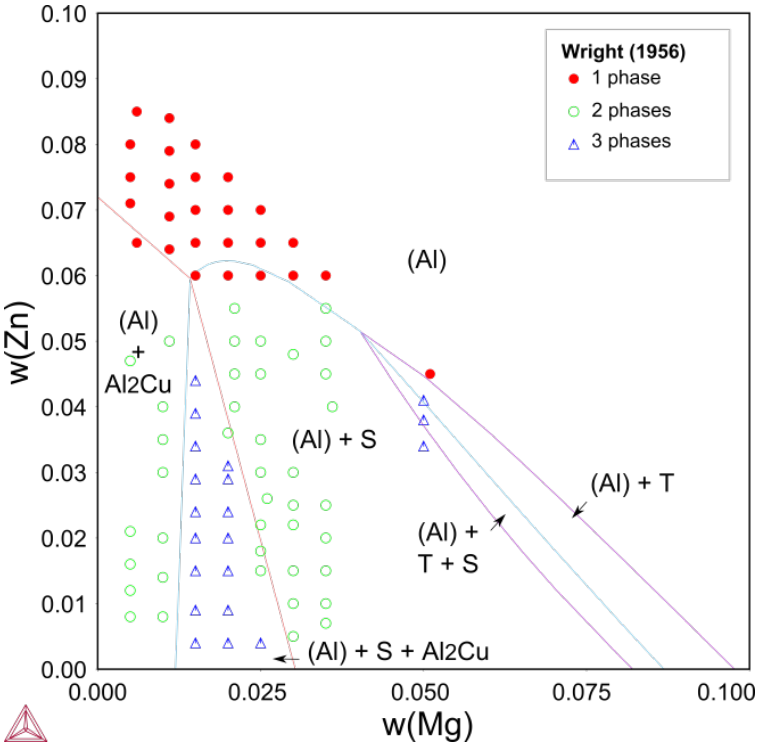

Fig.19: Calculated isothermal sections of the Al-Cu-Mg-Zn system at 90 wt.% Al (experimental data are from Wright [1956]).

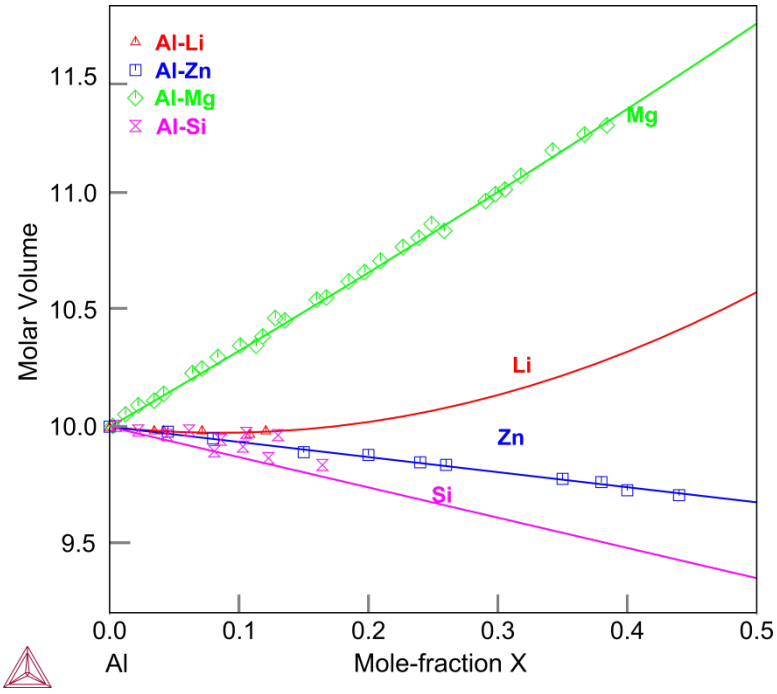

Fig.20: Calculated molar volumes of the Al-X (X=Li, Mg, Si, Zn) fcc_A1 phase.

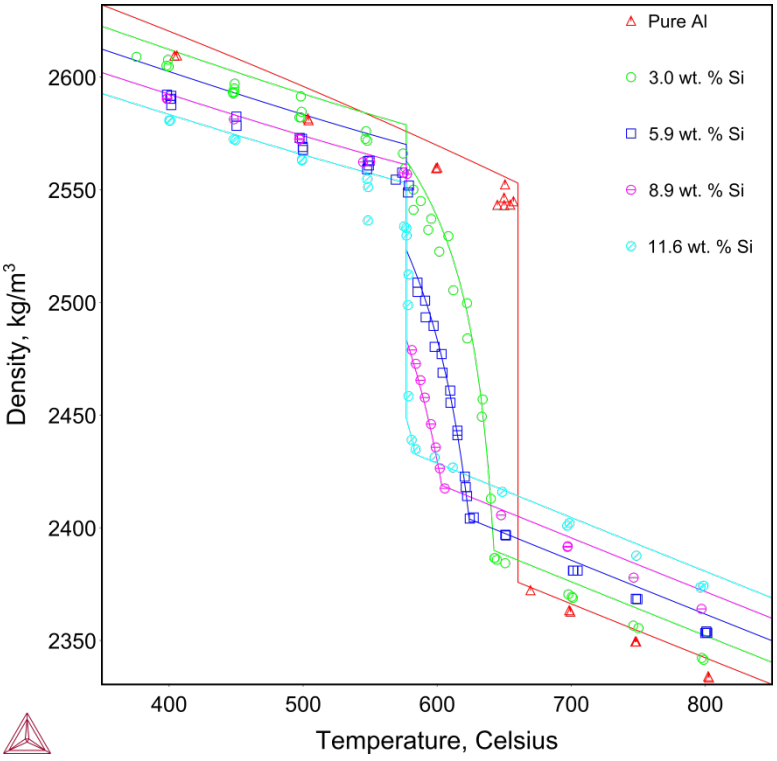

Fig.21: Calculated densities of pure Al and Al-Si alloys versus the temperature, in comparison with experimental data from Magnusson and Arnberg [2001].

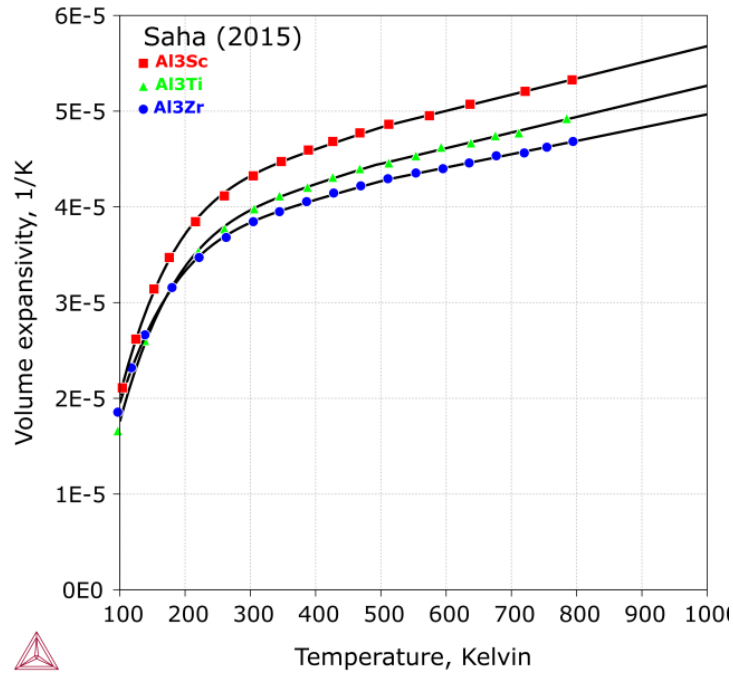

Fig. 22: Calculated volume thermal expansivity for Al_3Sc, Al_3Ti and Al_3Zr [Chen, 2017e].

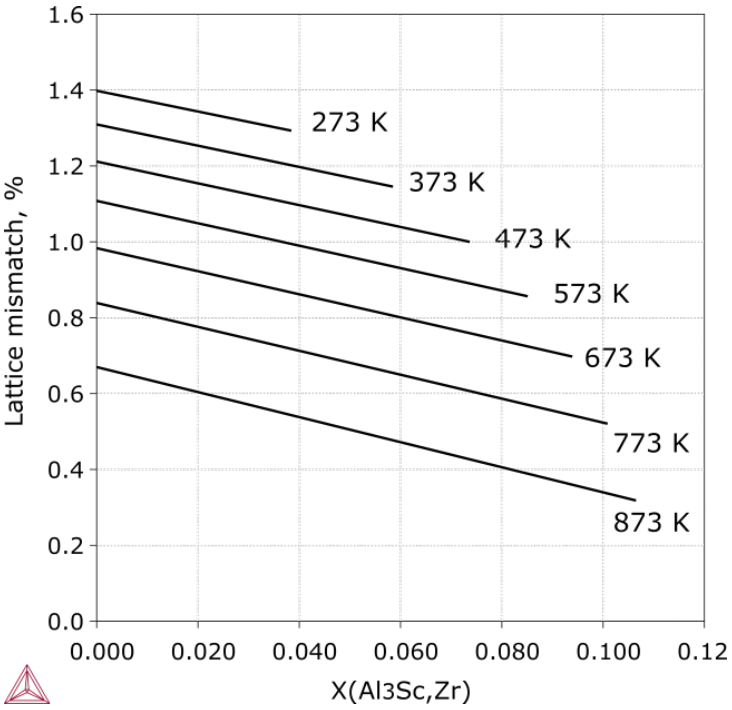

Fig. 23: Lattice mismatch between Al_3Sc and (Al), at different Zr contents and temperatures [Chen, 2017e].

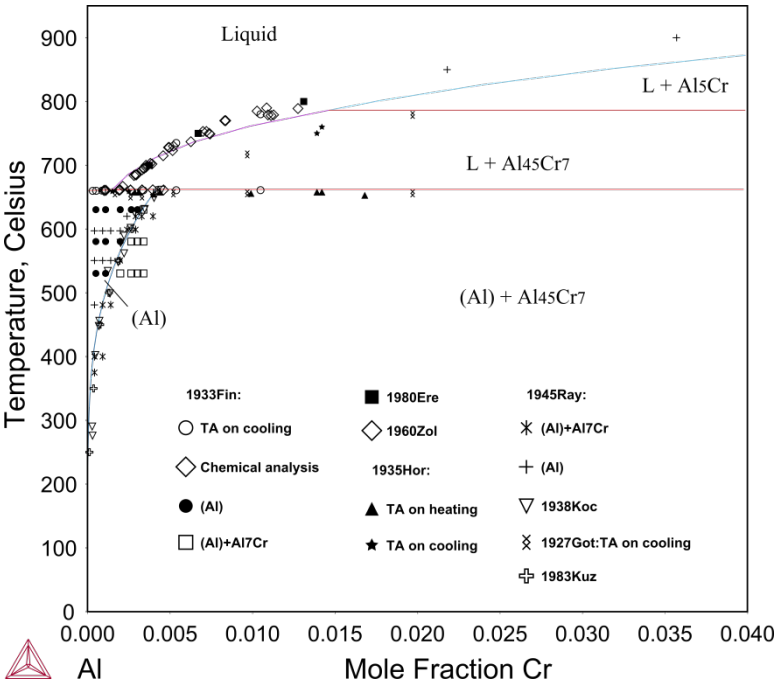

Fig.24: Calculated Al-rich Al-Cr binary phase diagram. Experimental data are from Fink and Freche [1933], Raynor and Little [1945] and Eremenko et al. [1980].

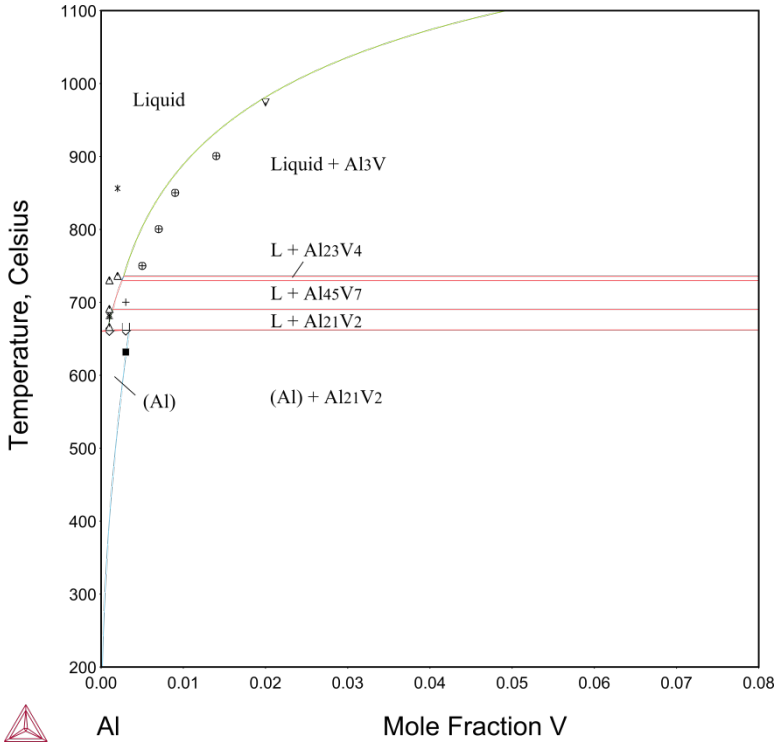

Fig.25: Calculated Al-rich Al-V binary phase diagram. Experimental data were read from Gong et al. [2004].

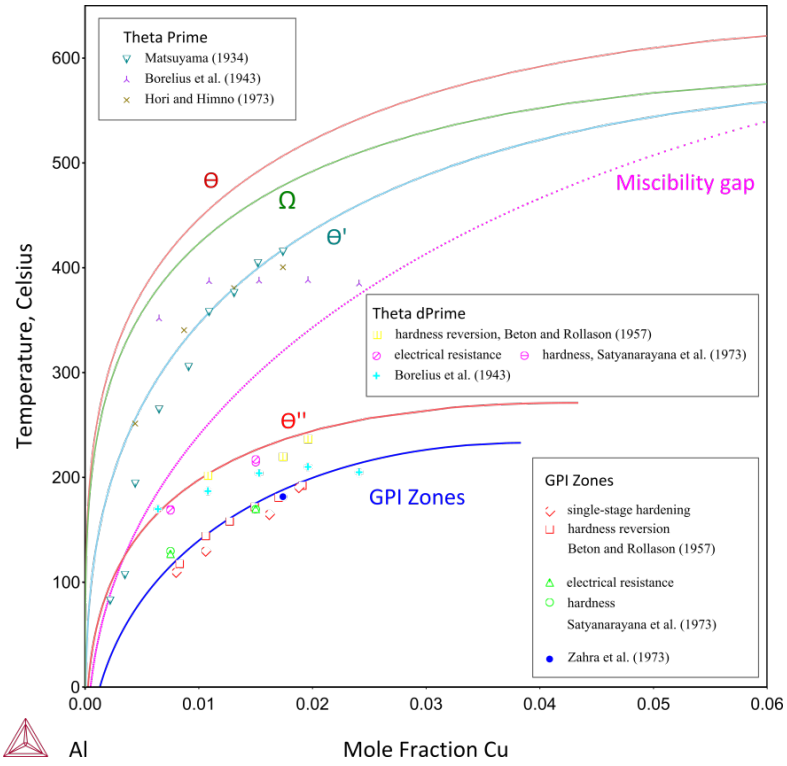

Fig.26: Calculated Al-Cu (Al) solvus curves equilibrated with θ, Ω, θ', θ'' (or GPII zones) and GPI zones, respectively. A metastable miscibility gap of fcc_A1 is shown. The GPI zones were modeled as the second composition set of fcc_A1, i.e. fcc_A1#2. It is assumed that experimentally observed GPI zones are usually tiny (say < 3 nm), so the interfacial and elastic energy are considered. The line for GPI zones was calculated with adding +800 J/mole-atoms to the energy of fcc_A1#2 [Chen, 2014b].

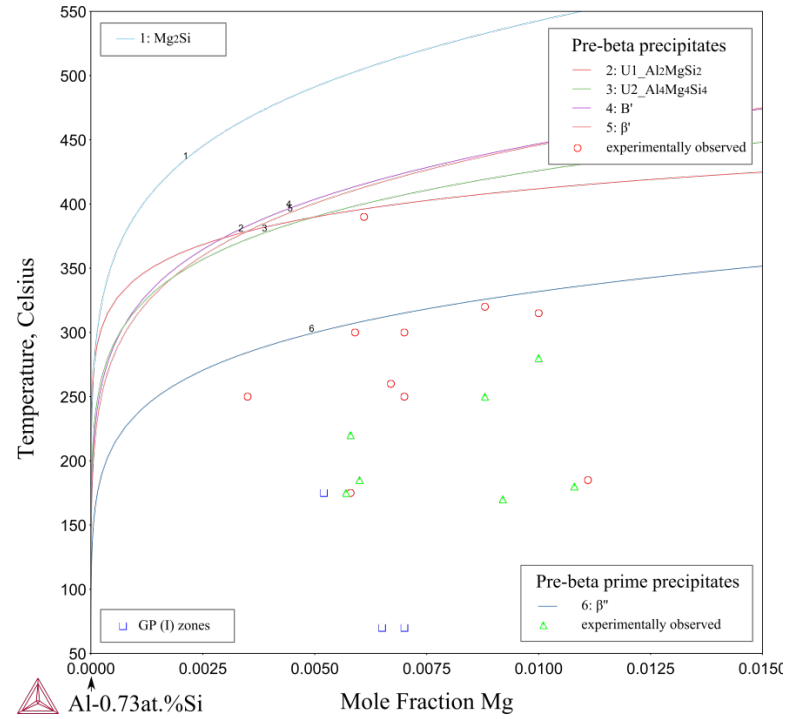

Fig.27: Calculated fcc_A1 solvi in alloys at 0.73 at.% Si and varying Mg content, relative to different Al-Mg-Si precipitates, including the stable β-Mg_2Si phase, pre-β precipitates (β', U1, U2 and B')and the pre-β' precipitate, i.e. β''. The symbols indicate certain precipitates have been experimentally observed in alloys of given compositions and aged at given temperatures [Chen, 2014b].

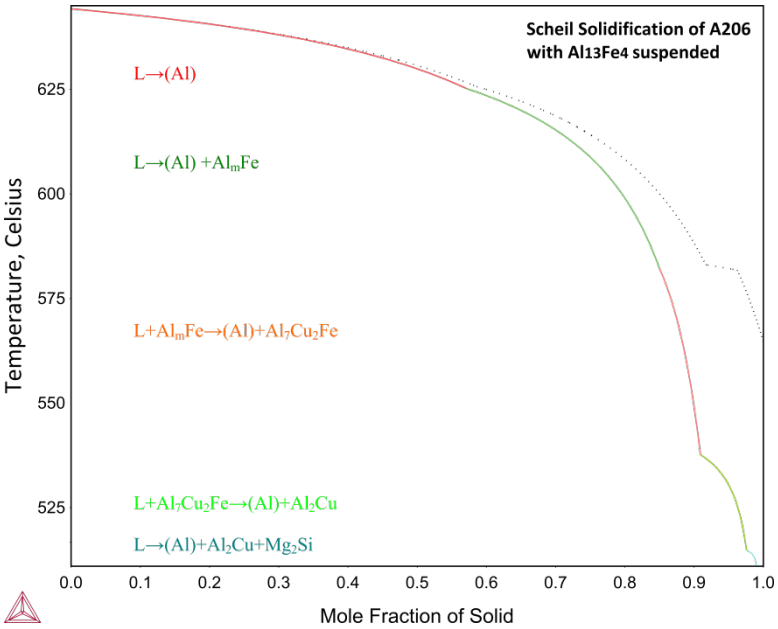

Fig.28: Scheil solidification of an A206 alloy (Al-4.58Cu-0.28Mg-0.51Fe-0.07Si-0.003Mn, wt.%) with the $Al_{13}Fe_4$ phase suspended [Chen, 2014b]. According Liu et al. [2012], the metastable Al_mFe phase formed after (Al) during the solidification. The phase formation sequence and phase transformation temperatures can be well accounted for with this calculation.

TCAL References

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Phases Included in TCAL

The elements in phase names are rearranged in the alphabetical order except for carbides and borides, where B and C appear at the end. In order to designate the high-temperature and the low-temperature modifications of a phase, respectively, suffixes of "_HT" and "_LT" are used instead of using prefixes of "alpha-", "beta-" or "gamma".

One can list phases and constituents in the Database module and the GES module. For some phases, supplementary information has been included in their definitions. In order to show the information, it is recommended to use "List-System" or "List-Database" with the option of "Constituents" in the Database module.

LIQUID
FCC_A1
FCC_L12
BCC_A2
BCC_B2
CBCC_A12
CUB_A13
DHCP
HCP_A3
BETA_RHOMBO_B
GRAPHITE
RHOMBO_A7
TETRA_A6
C14_LAVES
C15_LAVES
C36_LAVES
DIAMOND_A4
BCT_A5
ORTHORHOMBIC_GA
SIGMA

AL45V7
CUZR2_C11B
B2_BCC
ALB2_C32
FEB_B27
AL3TI_D022
ALZR2_B82
CAZN13_CF112
NI3SN_D019
CRB_B33
AL3ZR5_D8M
AL2SR_OI12
CACU5_D2D
M3B4_D7B
SI2ZR3_D5A
CO2SI_C23
CR5B3_D81
M11GE8_OP76
SIZR3_TP32
SI4ZR5_TP36

SI2ZR_C49
SI2TI_C54
ZRM5_C15B
FEM_B35
SN5TI6_OI44
M7C3_D101
M23C6_D84
V_PHASE
AGER
AG2ER
AG51ER14
AGLA
AG2LA
AG51LA14
AG5LA
AGMG3
AGMG4
AG2NA
AGZN3
AGZN

AG5ZN8
ALCU_DEL
ALCU_EPS
ALCU_ETA
AL2CU_C16
AL2CU_OMEGA
THETA_PRIME
THETA_DPRIME
ALCU_ZETA
GAMMA_D83
GAMMA_H
ALER
AL2ER3
ALER2
AL2FE1
AL5FE2
AL5FE4
AL13FE4
AL4FE
ALMG_BETA
ALMG_EPS
ALMG_GAMMA
ALMGZN_PHI
AL12MN
AL6MN
AL4MN_R

AL4MN_U
AL11MN4_LT
AL11MN4_HT
AL8MN5
AL3NI_D011
AL3NI2
AL3NI5
CA2CU
CACU
HCP_CA
CAH2_LT
CAH2_HT
CALI2
CA2NI7
CANI3
CA3SI4
CA14SI19
CASI2
CA3ZN
CA5ZN3
CAZN
CAZN2
CAZN3
CAZN11
CU9ER2
CU7ER2

CU5ER_C15B
CU2ER
CUER_B2
CU9GA4_0
CU9GA4_1
CU9GA4_2
CU9GA4_3
CUGA2
CUGA_THETA
CU5HF
CU51HF14
CU8HF3
CU10HF7
CU1HF2
CUIN_GAMMA
CUIN_THETE
CU2IN_HT
CU2IN_LT
CU11IN9
CU37LA3
CU6LA1_LT
CU6LA1_HT
CU5LA1
CU4LA1
CU2LA1
CU1LA1

CUMG2
CU4SC
CU2SC_C11B
CUSC
CU33SI7_DELTA
CU15SI4_EPSILON
CU56SI11_GAMMA
CUSI_ETA
EPSILON
FE3ER
FE23ER6
FE17ER2
MG24R5
ER5SI3
ER5SI4
ERSI_OC8
ERSI_OP8
ERSI2
C14_FE2HF
C36_FE2HF
C15_FE2HF
FE1HF2
FE2SC_C15
FE6SC29
FE2SI
FESI2_H

FESI2_L
FESI_B20
MN5SI3_D88
GAMMA_D82
FEZN_GAMMA1
FEZN_DELTA
FEZN_ZETA
LAH3
MGH2
HFMN
KNA2
KZN13
LA3NI
LA7NI3
LANI
LA2NI3
LA7NI16
LANI3
LA2NI7_LT
LA2NI7_HT
LANI5
LA3SI2
LA5SI3
LA5SI4
LASI
LASI2_A1

LASI2_A2
LAZN2
LAZN4
LAZN5
LA3ZN22
LAZN11
LAZN13
LA2ZN17
LI2ZN3_L
LI2ZN3_H
LI2ZN5_L
LI2ZN5_H
LIZN4_L
LIZN4_H
LIZN2
BCC_B32
MG2NI
MG2SI_C1
MG7ZN3
MGZN
MG2ZN3
L10_TETRA
MNNI2
MNSC4
MN11SI19
MN3SI

MN6SI
MN9SI2
MNZN9
NASI_LT
NASI_HT
NAZN13
NI5HF
NI7HF2
NI3HF_LT
NI3HF_HT
NI21HF8
NI7HF3
NI10HF7
NI11HF9
NIHF_LT
NIHF_HT
NIHF2
HF2SI
HF3SI2
HF5SI3
HFSI
HF5SI4
HFSI2
TET_A6P
NI2SI_HT
NI3SI2

NI3SI_HT
L12_FCC
NI3SI_MT
NI5SI2
NISI_B31
NISI2
NIZN_LT
NIZN8
ALB12
AL4C3
AL5CR
AL4CR
ALCR_GAMMA1
GAMMA_D810
AL7SR8
AL4M_D13
AL2TI
AL5TI2
AL5TI3
AL3TI_LT
ALTI3_D019
AL21V2
AL23V4
AL8V5
AL4ZR5
AL3ZR2_OF40

AL2ZR3_TP20
AL3ZR_D023
CU6SN5_HT
CUSN_GAMMA
CU10SN3
CU3SN
CU41SN11
CU6SN5_LT
CUSR
CU2TI
CU3TI2
CU4TI1
CU4TI3
CUTI_B11
CUTI3
CU10ZR7
CU51ZR14
CU8ZR3
FE2GE1
FEGE_ETA
FE6GE5
FE2GE3
FE5SN3_D82
FE3SN2
FEZR3
MGB4

MGB7
MG2C3
MGC2
MG2SR
MG38SR9
MG23SR6
MG17SR2
MN2B_D1F
MNB4
M5C2
CR3MN5
HIGH_SIGMA
GEMN3_HT
GE2MN3
GE2MN5
GE3MN7
MN2SN
MN3SN2
MNTI_LT
MNTI_HT
MN3TI
MN4TI
MNV_SIGMA
NI4B3_ORTH
NI4B3_MONO
GENI2

GE3NI5_HT
GE2NI3
GENI3_GAMMA
GE2NI5
GE3NI5_LT
GE12NI19
NI7SC2
NISC_B2
NISC2
NI3SN2_LT
NI3SN_HT
NI3SN2_HT
NI3SN4
NISR
NI3TI_D024
NITI2
NI2V7
NI2V1
NI10ZR7
NI21ZR8
NI11ZR9
NI7ZR2
SC5SI3
SCSI
SC3SI5_LT
SC3SI5_HT

SCZN
SCZN2
SC13ZN58
SC3ZN17
SCZN12
SIB3
SIB6
SIBX
SIC
CR3SI
CRSI2_C40
SI2SR_HT
SI2SR_LT
SI3TI5_D88
V3SI
CRZN13
CRZN17
SRZN5_LT
TIZN2
TIZN5
TIZN10
TIZN15
V4ZN5
ZN2ZR
ZN22ZR
ZN39ZR5

ZN3ZR_LT	CESI2	V3SN
ZN3ZR_HT	CE7NI3	VSN2
B4C	CENI	SN3ZR5
CR2B_ORTH	CENI2	SNZR3_A15
CRB4	CENI3	V2ZR
SRB6	CE2NI7	AL14CA13
V2B3	CENI5	AL3CA8
V5B6	CR3C2	AL4CE
ZRB12	V3C2	AL11CE3
CU6CE	CDCU2	AL3CE_H
CU5CE	CD3CU4	AL3CE_L
CU4CE	CD8CU5	ALCE
CU2CE	CD10CU3	ALCE2
CUCE	SN_HP1	ALCE3_H
CE2FE17	CR3GE	ALCE3_L
MGCE	CR5GE3_HT	AL13CO4
MG3CE	CR5GE3_LT	AL3CO
MG41CE5	CR11GE19	AL5CO2
MG17CE2	GE2SR	AL9CO2
MG12CE	GE3TI5	AL3LA
CE5SI3	V3GE	ALLA
CE3SI2	V17GE31	AL53LA22
CE5SI4	SR3SN5	AL11LA3_LT
CESI	SRSN3	AL11LA3_HT
CE3SI4	SRSN4	AL2LI3
CE3SI5	SN3TI2	ALLI2

AL4LI9
B32_ALLI
AL3X
AL2SC
ALSC
AL3HF4
LI22SI5
LI13SI4
LI7SI3
LI12SI7
AG9CA2
AG7CA2
AG2CA
AGCA3
AG4SC
AGSC
AL4C4SI
AL8C7SI
AL20CECR2
AL8CEM4
AL10CE2M7
AL3CECU
ALCEM
ALCE2CU2
ALCEFE
AL10CEFE2

AL8CEFE2
AL13CEMG6
AL2CENI
AL5CE2NI5
AL4CENI
AL5CE1NI2
AL23CE4NI6
AL60CE12NI28
AL40CE30NI30
ALCESI
AL7CE5SI3
ALCESI2
AL4CE3SI6
AL13CR4SI4
AL9CR3SI
ALCRSI_T3
ALCRSI_T4
AL9CU6ER5
AL5CU3ER2
AL3CU1ER1
AL62CU25FE13
AL7CU2FE
AL10CU10FE
AL2CULI
ALCULI_T2
ALCULI_R

ALCULI_B
Q_PHASE
S_PHASE
S_PRIME
T_PHASE
AL28CU4MN7
AL11CU5MN3
ALCU3MN2
AL7CU4NI
ALCUSC_TAU
AL6ER2FE11
AL7ERMG2
AL9FENI
AL10FE3NI
AL71FE5NI24
ALFESI_T1
ALFESI_T2
ALFESI_T3
ALFESI_T4
AL8FE2SI
AL9FE2SI2
ALFESI_T7
ALFESI_T8
ALFESI_T10
ALFESI_T11
ALFEZN_GAMMA

ALLIMG_T
ALLISI
AL3LI8SI5
ALLI5SI2
ALLI2ZR
AL18MG3MN2
ALMG3NI2
BETA_PRIME
B_PRIME
U1_AL2MGSI2
U2_AL4MG4SI4
BETA_DPRIME
ETA_PRIME
T_PRIME
AL31MN6NI2
AL2MN2SI3
AL5MN6SI7
AL1MN1SI1
AL3MNSI2
AL3MN4SI2
ALMNSI_T6
ALMNSI_T8
AL15SI2M4
AL2MNSI3

AL24MN5ZN
AL9MN2ZN
AL11MN3ZN2
ALNI2SI
AL6NI3SI
ALNI16SI9
ALNI2ZN
AL13NI38ZN49
ALSC2SI2
ALSI3TI2
ALSI7TI4
CULIMG_T
CU16MG6SI7
CU3MG2SI
CU5MN4SI
CUMNZN
CU6NISI3
CU46NI25SI29
FE5NI3SI2
ZN13M2
MG6MN3NI
MGNI6SI6
MG2NI3SI
MG10NI55SI35

MG2NI16SI11
MG5NI9SI
MG9NI29SI16
MGNI6ZN6
MN15NI45SI40
MN15NI50SI35
MN6NI16SI7
MN1NI1SI1
MNNISI_T5
MNNISI_T6
MN3NI2SI
MN2NISI
MN6NISI3
MN66NI4SI30
MN52NI29SI19
MN7NI7ZN86
NI2SIZN_T1
NI9SI2ZN_T2
NI2SIZN3_T3
NISIZN_T4
Q_ALCUMGSI
AL18FE2MG7SI10

Models for the Included Phases in TCAL

LIQUID

:AL CU ER FE MG MN NI SI ZN B C CR GE SN SR TI V ZR MG2GE MG2SN1 ZN2ZR AG CA HF H LIH K LA LI NA SC CO PB BE BI CE CD GA IN :

> Metallic LIQUID solution phase

FCC_A1 2 1 1

:AL CU ER FE MG MN NI SI ZN CR GE SN SR TI V ZR AG CA HF K LA LI NA SC CO PB BE BI CE CD GA IN:B C H VA :

> Metallic FCC_A1 solution, e.g. (Al), (Cu), and MC carbides

FCC_L12 3 0.75 0.25 1

:AL CU ER FE MG MN NI SI ZN CR GE SN SR TI V ZR AG CA HF K LA LI NA SC CO PB BE BI CE CD GA IN:AL CU ER FE MG MN NI SI ZN CR GE SN SR TI V ZR AG CA HF K LA LI NA SC CO PB BE BI CE CD GA IN:B C H VA :

> Solution of ordered FCC_L12, having Gibbs energy contribution from FCC_A1

BCC_A2 2 1 3

:AL CU ER FE MG MN NI SI ZN VA GE CR SN SR TI V ZR AG CA HF K LA LI NA

SC CO PB BE BI CE CD GA IN:B C H VA :

> Metallic BCC_A2 solution

BCC_B2 3 0.5 0.5 3

:AL CU ER FE MG MN NI SI TI ZN VA GE CR SN SR V ZR AG CA HF K LA LI NA

SC CO PB BE BI CE CD GA IN:AL CU ER FE MG MN NI SI TI ZN VA GE CR SN SR V

ZR AG CA HF K LA LI NA SC CO PB BE BI CE CD GA IN:B C H VA :

> Solution of ordered BCC_B2, having Gibbs energy contribution from BCC_A2

CBCC_A12 2 1 1

:AL CO CU FE LI MG MN NI SI ZN CR GE SN SR TI V ZR:B C H VA :

CUB_A13 2 1 1

:AL CE CU FE HF LI MG MN NI SI ZN CR GE SN SR TI V ZR AG:B C H VA :

DHCP

:CU LA NI SC :

HCP_A3 2 1 0.5

:AG AL CU ER FE K LI MG MN NA NI SI ZN GE CR SN SR TI V ZR HF LA SC CO

PB BE BI CA CE CD GA IN:B C H VA :

> Metallic HCP_A3 solution, alpha_Mg/Hf/Sc/Ti/Zr, epsilon_CuZn, etc.

BETA_RHOMBO_B 2 93 12

:B:CU SI B C :

GRAPHITE

:B C :

RHOMBO_A7

:BI IN SN :

TETRA_A6

:IN SN :

C14_LAVES 2 2 1

:AL CU CR FE HF LI MG MN NI TI ZN ZR:AL CU CR ER FE HF MG MN SC TI ZN ZR :

> Solution of MgZn2-type phases, including MgZn2 (Eta, aka M or sigma)

C15_LAVES 2 2 1

:AL CA CU FE LI MG NI SC SI ZN CR TI ZR LA HF:AL CA CE CU ER FE LI MG NI

SC SI ZN CR TI ZR LA HF :

> Solution of Cu2Mg-type phases, cF24, Fd-3m

C36_LAVES 2 2 1

:AL CU CR FE HF MG MN NI ZN ZR:AL CU CR FE HF MG NI SC ZN ZR :

> Solution of MgNi2-type phases, hP24, P63/mmc

DIAMOND_A4

:AL SI ZN B C GA GE SR SN TI :

> Pure C, Ge, Si or solution phases based on them

BCT_A5

:AL B BI CD CU GA GE IN ZN PB SN TI :

> Pure Sn or its solution

GAS

:AL AL2 B B2 C C2 C3 C4 C5 C60 CA CA2 CO CO2 CR CR2 CU CU2 FE FE2 GE GE2 LI LI2 MG MG2 MN NI NI2 SC SI SI2 SI3 SN SN2 SR SR2 TI TI2 V ZN K K2 NA

NA2 H H2 AL1H1 AL1H2 AL1H3 CA1H1 CU1H1 H1LI1 H1NA1 K1LI1 :

ORTHORHOMBIC_GA

:GA :

SIGMA 3 8 4 18

:FE MN NI:CR V:FE CR MN NI V :

AL45V7 2 45 7

:AL:CR V :

> Al45Cr7, Al45V7

CUZR2_C11B 2 1 2

:AL CR CU SI ZN:AL CR TI ZR :

> AlCr2, CuTi2, CuZr2, Ti2Zn, ZnZr2

B2_BCC 2 1 1

:AL CO FE CU ZN:CO MN TI VA ZR :

> CuZr, FeTi, TiZn, ZnZr, MnZn(rt), AlCo

ALB2_C32 2 1 2

:MG AL MN CR ZR TI V:B :

> AlB2, B2Cr, B2Mg, B2Mn, B2Ti, B2V, B2Zr

FEB_B27 2 1 1

:FE MN TI ZR SR: B SI ZN GE :

> BFe, BMn, BTi, GeZr, SiTi, SrZn, SiZr

AL3TI_D022 2 3 1

:AL MN NI SI TI:AL GE MN SC TI V ZR :

> Al3Ti, Ni3V, GeMn3, Al3V

ALZR2_B82 2 1 2

:AL GE MN SN VA:ZR MN SC TI VA :

> SnTi2, GeMn2, AlZr2, AlSc2

CAZN13_CF112 2 1 13

:CA SR:ZN :

> CaZn13, SrZn13

NI3SN_D019 2 1 3

:AL SN GE VA:LA MN FE NI TI :

> Ni3Sn, SnTi3, SnMn3, AlLa3

CRB_B33 2 1 1

:AL CA CR NI SR V:AG B SI GE SC SN ZR HF :

> AgCa, AlHf, AlZr, BNi, BV, GeSr, NiZr, SiSr, SnSr

AL3ZR5_D8M 2 3 5
:AL SI GE:ZR CR V :
> Al3Zr5, Cr3Si5, Ge3V5, Si3V5

AL2SR_OI12 2 2 1
:AL ZN:SR :
> Al2Sr, SrZn2

CACU5_D2D 2 1 5
:CA SC SR:CU NI ZN :
> CaCu5, CaNi5, CaZn5, Cu5Sr, ScNi5, SrZn5

M3B4_D7B 2 4 3
:B:MN CR TI V :
> V3B4, Ti3B4, Mn3B4, Cr3B4

SI2ZR3_D5A 2 2 3
:SI B:ZR V :
> Si2Zr3, B2V3

CO2SI_C23 2 2 1
:CA CU FE NI SR:AL SI ZN GE SN :
> Ca2Si, Ni2Si, SiSr2, SnSr2, GeSr2

CR5B3_D81 2 0.625 0.375
:CA CR SR:AG SI B GE SN :
> Ca5Si3, Sn3Sr5, Si4Sr5, Ge3Sr5, B3Cr5

M11GE8_OP76 2 0.579 0.421
:CR V:GE :
> Cr11Ge8, V11Ge8

SIZR3_TP32 2 1 3
:SI GE:ZR TI :
> SiZr3, SiTi3, GeZr3

SI4ZR5_TP36 2 4 5
: SI GE:TI ZR :
> Si4Zr5, Si4Ti5, Ge4Zr5

SI2ZR_C49 2 2 1
:SI GE:ZR :
> Si2Zr, Ge2Zr

SI2TI_C54 2 2 1
:AL GE SI SN:TI ZR :
> Ge2Ti, Si2Ti, Sn2Zr

ZRM5_C15B 2 5 1
:CU NI:ZR :
> Cu5Zr, Ni5Zr

FEM_B35 2 1 1
:FE:SN GE :
> FeSn, FeGe

SN5TI6_OI44 2 5 6
:GE SN SI:V TI :
> Sn5Ti6, Si5V6, Ge5Ti6

M7C3_D101 2 7 3
:MN CR:C :
> Cr7C3, Mn7C3

M23C6_D84 2 23 6
:MN CR:C SC :
> Cr23C6, Mn23C6, Mn23SC6

V_PHASE 3 5 6 2

:AL SI ZN:CU ZN:MG :

> solution of Mg2Zn11, Al5Cu6Mg2; aka Z

AGER 2 1 1

:AG:ER :

AG2ER 2 2 1

:AG:ER :

AG51ER14 2 0.77 0.23

:AG:ER :

AGLA 2 1 1

:LA:AG :

AG2LA 2 1 2

:LA:AG :

AG51LA14 2 14 51

:LA:AG :

AG5LA 2 1 5

:LA:AG :

AGMG3 2 0.23 0.77

:AG:MG :

> Ag17Mg54

AGMG4 2 0.2 0.8

:AG:MG :

> Ag9Mg37

AG2NA 2 2 1

:AG:NA :

AGZN3

:AG ZN :

AGZN 2 1 2

:ZN:AG ZN :

AG5ZN8 4 2 2 3 6

:AG ZN:AG:AG ZN:AG ZN :

ALCU_DEL 2 2 3

:AL ZN:CU FE :

ALCU_EPS 2 1 1

:AL CU ZN NI:CU FE :

ALCU_ETA 2 1 1

:AL CU:CU FE ZN NI :

AL2CU_C16 2 2 1

:AL FE GE SN ZR MN NI HF:AL CU FE NI B MN SI :

> Al2Cu, AlHf2, Fe2B, FeGe2, FeZr2, FeSn2, Mn2B, MnSn2, NiB2, NiZr2, SiZr2

AL2CU_OMEGA 2 2 1

:AL:CU :

> Al2Cu-OMEGA metastable precipitate

THETA_PRIME 2 2 1

:AL:CU :

THETA_DPRIME 2 3 1

:AL:CU :

ALCU_ZETA 2 9 11

:AL:CU FE :

GAMMA_D83 3 4 1 8
:AL FE NI SI ZN:AL CU NI SI ZN:AG CU MN FE NI ZN :
> solution between Al8Cu5 (rt) and Cu5Zn8

GAMMA_H 3 4 1 8
:AL ZN:AL CU ZN:CU MN FE NI :
> Cu5Zn8-type Al8Cu5 (ht) phase

ALER 2 0.5 0.5
:AL MG:ER :

AL2ER3 2 0.4 0.6
:AL MG:ER :

ALER2 2 0.33333 0.66667
:AL MG:ER :

AL2FE1 2 2 1
:AL CU SI ZN:FE MN NI :

AL5FE2 2 5 2
:AL CU SI ZN:FE MN NI :

AL5FE4
:AL CU FE MN :

AL13FE4 3 0.6275 0.235 0.1375
:AL CU:FE MN NI ZN:AL SI VA ZN :
> solution phases based on Al13Fe4, aka Al3Fe

AL4FE 2 4.2 1
:AL:FE :

ALMG_BETA 2 89 140
:MG LI:AL ZN :

ALMG_EPS 2 23 30
:MG:AL ZN :

ALMG_GAMMA 3 5 12 12
:LI MG:AL MG ZN:AL MG ZN :

ALMGZN_PHI 2 6 5
:MG:AL ZN :
> a Al-Mg-Zn ternary phase know as PHI

AL12MN 2 12 1
:AL:MN :

AL6MN 2 6 1
:AL CU ZN:MN FE CU:

AL4MN_R 2 0.81162 0.18838
:AL:MN FE :
> AL461MN107

AL4MN_U 2 4 1
:AL ZN:MN :

AL11MN4_LT 2 11 4
:AL ZN:MN FE :

AL11MN4_HT 2 29 10
:AL MN:MN :

AL8MN5 3 12 5 9
:AL ZN:MN:AL MN SI CU :

AL3NI_D011 2 0.75 0.25
:AL MN NI:FE NI B C :

AL3NI2 3 3 2 1
:AL SI ZN:AL CU FE MG NI:NI VA :

AL3NI5 2 0.375 0.625
:AL:NI :

CA2CU 2 2 1
:CA:CU :

CACU 2 1 1
:CA:CU :

HCP_CA 2 1 0.5
:CA:H VA :

CAH2_LT 2 1 2
:CA:H :

CAH2_HT 2 1 2
:CA:H :

CALI2 2 2 1
:LI:CA :

CA2NI7 2 2 7
:CA:NI :

CANI3 2 0.25 0.75
:CA:NI :

CA3SI4 2 0.428571 0.571429
:CA:SI :

CA14SI19 2 0.424242 0.575758
:CA:SI :

CASI2 2 0.333333 0.666667
:CA:SI :

CA3ZN 2 3 1
:CA:ZN :

CA5ZN3 2 5 3
:CA:ZN :

CAZN 2 1 1
:CA:ZN :

CAZN2 2 1 2
:CA:ZN :

CAZN3 2 1 3
:CA:ZN :

CAZN11 2 1 11
:CA:ZN :

CU9ER2 2 9 2
:CU:ER :

CU7ER2 2 7 2
:CU:ER :

CU5ER_C15B 2 5 1
:CU:ER :

CU2ER 2 2 1
:AL CU:ER :

CUER_B2 2 1 1
:AL CU:ER :

CU9GA4_0 3 6 6 1
:CU:CU GA:GA :

CU9GA4_1 4 6 3 3 1
:CU:CU GA:CU GA:GA :

CU9GA4_2 4 3 3 3 4
:CU:CU VA:CU GA:GA :

CU9GA4_3 3 6 3 4
:CU VA:CU GA:GA :

CUGA2 2 1 2
:CU:GA :

CUGA_THETA 2 0.778 0.222
:CU:GA :

CU5HF 2 5 1
:CU:HF :

CU51HF14 2 51 14
:CU:HF :

CU8HF3 2 8 3
:CU:HF :

CU10HF7 2 10 7
:CU:HF :

CU1HF2 2 1 2
:CU:HF :

CUIN_GAMMA 4 2 2 3 6
:CU:CU IN:CU:CU IN :

CUIN_THETE 2 0.7 0.3
:CU:IN :

CU2IN_HT 3 0.545 0.122 0.333
:CU:CU IN:IN :

CU2IN_LT 2 0.64 0.36
:CU:IN :

CU11IN9 2 0.55 0.45
:CU:IN :

CU37LA3 2 37 3
:CU:LA :

CU6LA1_LT 2 6 1
:CU:LA :

CU6LA1_HT 2 6 1
:CU:LA :

CU5LA1 2 5 1
:CU:LA :

CU4LA1 2 4 1
:CU:LA :

CU2LA1 2 2 1
:CU:LA :

CU1LA1 2 1 1
:CU:LA :

CUMG2 2 1 2
:CU NI:MG :

CU4SC 2 4 1
:CU:SC :

CU2SC_C11B 2 2 1
:AG CU:SC :

CUSC 2 1 1
:CU:SC :

CU33SI7_DELTA 2 0.825 0.175
:CU ZN:SI :

CU15SI4_EPSILON 2 0.789474 0.210526
:CU MG MN ZN:AL SI :

CU56SI11_GAMMA 2 0.835821 0.164179
:CU MG MN NI SI ZN:SI :

CUSI_ETA 2 0.76 0.24
:CU MN NI ZN:SI :

EPSILON
:CU MN ZN :

FE3ER 2 3 1
:FE:ER :

FE23ER6 2 23 6
:AL FE:ER :

FE17ER2 2 17 2
:AL FE:ER :

MG24R5 2 5 24
:ER MG:AL MG :

ER5SI3 2 0.625 0.375
:ER:SI :

ER5SI4 2 0.555556 0.444444
:ER:SI :

ERSI_OC8 2 0.51 0.49
:ER:SI :

ERSI_OP8 2 0.5 0.5
:ER:SI :

ERSI2 2 0.37 0.63
:ER:SI :

C14_FE2HF 2 0.6667 0.3333
:FE:HF FE :

C36_FE2HF 2 0.6667 0.3333
:FE:HF :

C15_FE2HF 2 0.6667 0.3333
:FE:HF :

FE1HF2 2 0.3333 0.6667
:FE:HF :

FE2SC_C15 2 0.64 0.36
:FE:SC :

FE6SC29 2 0.17 0.83
:FE:SC :

FE2SI 2 2 1

:FE NI:AL SI :

FESI2_H 2 3 7
:FE NI:AL MG SI :

FESI2_L 2 1 2
:FE NI:AL SI :

FESI_B20 2 1 1
:FE MN NI CR:AL MG SI GE :
> FeSi, MnSi, CrSi, CrGe

MN5SI3_D88 2 5 3
:CU FE MN NI CR ZR TI:AL CR SI GE SN:
> Mn5Si3, Cr3Si5, Fe5Si3, Ge3Mn5, Ge3Zr5, Si3Zr5, Sn3Ti5

GAMMA_D82 4 2 2 3 6
:FE MN ZN:FE MN NI ZN:AL CU FE MN NI SI ZN:AL ZN :

FEZN_GAMMA1 3 0.137 0.118 0.745
:FE:AL CU FE NI SI ZN:MN ZN :

FEZN_DELTA 4 5.8E-2 0.18 0.525 0.237
:FE:AL CU FE MN NI SI ZN:ZN:ZN :

FEZN_ZETA 3 7.2E-2 0.856 7.2E-2
:FE MN NI VA:AL ZN:AL CU SI VA ZN :

LAH3 3 0.25 0.5 0.25
:LA:H VA:H VA :

MGH2 2 1 2
:MG:H :

HFMN 2 0.5 0.5
:HF:MN :

KNA2 2 1 2
:K:NA :

KZN13 2 1 13
:K:ZN :

LA3NI 2 3 1
:LA:NI :

LA7NI3 2 7 3
:LA:NI :

LANI 2 1 1
:LA:NI :

LA2NI3 2 2 3
:LA:NI :

LA7NI16 2 7 16
:LA:NI :

LANI3 2 1 3
:LA:NI :

LA2NI7_LT 2 2 7
:LA:NI :

LA2NI7_HT 2 2 7
:LA:NI :

LANI5 2 1 5
:LA:NI :

LA3SI2 2 0.6 0.4
:LA:SI :

LA5SI3 2 0.625 0.375
:LA:SI :

LA5SI4 2 0.5556 0.4444
:LA:SI :

LASI 2 0.5 0.5
:LA:SI :

LASI2_A1 2 0.36 0.64
:LA:SI :

LASI2_A2 2 0.3333 0.6667
:LA:SI :

LAZN2 2 0.333 0.667
:LA:ZN :

LAZN4 2 0.2 0.8
:LA:ZN :

LAZN5 2 0.1667 0.8333
:LA:ZN :

LA3ZN22 2 0.12 0.88
:LA:ZN :

LAZN11 2 8.3E-2 0.917
:LA:ZN :

LAZN13 2 7.1E-2 0.929
:LA:ZN :

LA2ZN17 2 0.105 0.895
:LA:ZN :

LI2ZN3_L 2 2 3
:LI:LI ZN :

LI2ZN3_H 2 2 3
:LI ZN:LI ZN :

LI2ZN5_L 2 2 5
:LI ZN:ZN :

LI2ZN5_H 2 2 5
:LI ZN:ZN :

LIZN4_L 2 1 4
:LI ZN:LI ZN :

LIZN4_H 2 0.2 0.8
:LI ZN:LI ZN :

LIZN2 2 1 2
:LI:ZN :

BCC_B32 2 1 1
:LI ZN:LI ZN :

MG2NI 2 2 1
:MG ZN:CU NI ZN :

MG2SI_C1 2 2 1
:MG:GE SI SN :
> solution phase of Mg2Si, GeMg2, Mg2Sn

MG7ZN3 2 51 20
:MG:ZN :

MGZN 2 12 13
:MG:AL CU ZN :

MG2ZN3 2 2 3
:MG:AL CU ZN :

L10_TETRA 2 0.5 0.5
:AL CU MN NI TI:AL CU MN NI TI :

MNNI2 2 1 2
:MN NI:NI :

MNSC4 2 0.2 0.8
:MN:SC :

MN11SI19 2 11 19
:MN:AL SI :

MN3SI 2 3 1
:FE MN NI:AL SI :

MN6SI 2 17 3
:AL MN:SI ZN :

MN9SI2 2 33 7
:MN:SI :

MNZN9 2 0.1 0.9
:MN:ZN :

NASI_LT 2 1 1
:NA:SI :

NASI_HT 2 1 1
:NA:SI :

NAZN13 2 1 13
:NA:ZN :

NI5HF 2 0.833 0.167
:NI:HF :

NI7HF2 2 0.778 0.222
:NI:HF NI :

NI3HF_LT 2 0.75 0.25
:NI:HF :

NI3HF_HT 2 0.75 0.25
:NI:HF :

NI21HF8 2 0.724 0.276
:NI:HF :

NI7HF3 2 0.7 0.3
:NI:HF :

NI10HF7 2 0.588 0.412
:NI:HF :

NI11HF9 2 0.55 0.45
:NI:HF :

NIHF_LT 2 0.5 0.5
:NI:HF :

NIHF_HT 2 0.5 0.5
:NI:HF :

NIHF2 2 1 2
:NI VA:HF :

HF2SI 2 0.6666667 0.3333333
:HF:SI :

HF3SI2 2 0.6 0.4
:HF:SI :

HF5SI3 2 0.625 0.375
:HF:SI :

HFSI 2 0.5 0.5
:HF:SI :

HF5SI4 2 0.555556 0.444444
:HF:SI :

HFSI2 2 0.333333 0.666667
:HF:SI :

TET_A6P
:IN SN :

NI2SI_HT 3 1 1 1
:CU NI:NI VA:AL SI :

NI3SI2 2 3 2
:FE NI:SI :

NI3SI_HT 2 3 1
:FE NI:AL SI :

L12_FCC 2 1 3
:AL GE NI SI TI V:AL FE ZR NI ZN :
> L12 phase, Ni3Si_rt, AlZr3, GeNi3, TiZn3, VZn3

NI3SI_MT 2 1 3
:SI:NI :

NI5SI2 2 5 2
:CU FE NI:AL SI :

NISI_B31 2 1 1
:FE NI:GE SI ZN :
> GeNi, NiSi

NISI2 2 2 1
:AL CU SI ZN:CU FE MN NI :

NIZN_LT 2 0.5 0.5
:AL FE MN NI SI ZN:AL FE MG MN NI SI ZN :

NIZN8 2 0.1111111 0.8888889
:NI:AL MN ZN :

ALB12 2 1 12
:AL:B :

AL4C3 2 4 3
:AL SI:C :

AL5CR 2 5 1
:AL SI:CR :

AL4CR 2 1 4
:CR:AL SI VA :

ALCR_GAMMA1 4 2 2 3 6
:AL CR SI:CR:AL CR:AL SI :

GAMMA_D810 3 12 5 9
:AL SI:CR:AL CR SI :

AL7SR8 2 7 8
:AL:SR :

AL4M_D13 2 4 1
:AL:CA SR :
> Al4Ca, Al4Sr

AL2TI 2 2 1
:AL TI:AL SC TI :

AL5TI2 2 5 2
:AL TI:AL TI :

AL5TI3 2 5 3
:AL:TI :

AL3TI_LT 2 3 1
:AL SI TI:AL SC TI :

ALTI3_D019 2 3 1
:AL TI:AL SI TI :

AL21V2 2 21 2
:AL:V :

AL23V4 2 23 4
:AL:V :

AL8V5 4 2 2 3 6
:AL V:V:AL V:AL :

AL4ZR5 2 4 5
:AL:SC ZR :

AL3ZR2_OF40 2 3 2
:AL LI:SC HF ZR :
> Al3Zr2, Al3Hf2

AL2ZR3_TP20 2 2 3
:AL ZN:SC HF ZR :
> Al2Zr3, Al2Hf3, ZN2Zr3

AL3ZR_D023 2 3 1
:AL LI:SC HF TI ZR :
> Al3Zr, Al3Hf

CU6SN5_HT 3 1 1 1
:CU:CU SN:SN :

CUSN_GAMMA
:CU SN :

CU10SN3
:CU SN :

CU3SN 2 3 1
:CU SN:CU SN :

CU41SN11 2 41 11
:CU SN:CU SN :

CU6SN5_LT 3 1 1 1
:CU:CU SN:SN :

CUSR 2 1 1
:SR:CU :

CU2TI 2 2 1
:CU:TI :

CU3TI2 2 3 2

:CU:TI :

CU4TI1 2 4 1
:CU TI:CU TI :

CU4TI3 2 4 3
:CU:TI :

CUTI_B11 2 1 1
:CU TI:CU TI :

CUTI3 2 1 3
:CU TI:TI :

CU10ZR7 2 10 7
:CU:ZR :

CU51ZR14 2 51 14
:CU:ZR :

CU8ZR3 2 8 3
:CU:ZR :

FE2GE1 3 1 1 1
:FE:FE VA:GE :

FEGE_ETA 2 13 9
:FE:GE :

FE6GE5 2 6 5
:FE:GE :

FE2GE3 2 2 3
:FE:GE :

FE5SN3_D82 2 5 3
:FE:SN :

FE3SN2 2 3 2
:FE:SN :

FEZR3 2 1 3
:FE:ZR :

MGB4 2 1 4
:MG:B :

MGB7 2 1 7
:MG:B :

MG2C3 2 2 3
:MG:C :

MGC2 2 1 2
:MG:C :

MG2SR 2 2 1
:MG:SR :

MG38SR9 2 38 9
:MG:SR :

MG23SR6 2 23 6
:MG:SR :

MG17SR2 2 17 2
:MG:SR :

MN2B_D1F 2 0.6707 0.3293
:MN:B :

MNB4 2 0.2 0.8

:MN:B :

M5C2 2 5 2
:MN:C :

CR3MN5 2 3 5
:CR:MN :

HIGH_SIGMA 3 8 4 18
:MN:CR:CR MN :

GEMN3_HT 2 1 3
:GE MN:MN :

GE2MN3 2 2 3
:GE:MN :

GE2MN5 2 2 5
:GE MN:MN :

GE3MN7 2 3 7
:GE:MN :

MN2SN 2 0.643 0.357
:MN:SN :
> Mn(2-x)Sn

MN3SN2 2 3 2
:MN:SN :

MNTI_LT 2 1 1
:MN:TI :

MNTI_HT 2 0.515 0.485
:MN:TI :

MN3TI 2 3 1
:MN:TI :

MN4TI 2 0.815 0.185
:MN:TI :

MNV_SIGMA 3 10 4 16
:MN V:V:MN V :

NI4B3_ORTH 2 0.586 0.414
:NI:B :

NI4B3_MONO 2 0.564 0.436
:NI:B :

GENI2 2 0.665 0.335
:NI:GE :

GE3NI5_HT 2 0.625 0.375
:GE NI:GE NI :

GE2NI3 2 0.6 0.4
:GE NI:GE :

GENI3_GAMMA 2 0.744 0.256
:NI:GE :

GE2NI5 2 0.72 0.28
:NI:GE :

GE3NI5_LT 2 0.63 0.37
:NI:GE :

GE12NI19 2 0.613 0.387
:GE NI:GE NI :

NI7SC2 2 0.222222 0.777778
:SC:NI :

NISC_B2 2 1 1
:SC:NI :

NISC2 2 0.72 0.28
:SC:NI :

NI3SN2_LT 3 0.2 0.4 0.4
:SN:NI SN:NI :

NI3SN_HT 3 0.25 0.25 0.5
:NI SN:NI SN:NI :

NI3SN2_HT 3 0.33333 0.33334 0.33333
:NI:NI SN:SN :

NI3SN4 3 0.25 0.25 0.5
:NI:NI SN:SN :

NISR 2 0.5 0.5
:NI:SR :

NI3TI_D024 2 0.75 0.25
:NI TI:NI TI :

NITI2 2 1 2
:NI TI:NI TI :

NI2V7 2 2 7
:NI:V :

NI2V1 2 2 1
:NI:V :

NI10ZR7 2 23 17
:NI:ZR :

NI21ZR8 2 8 21
:ZR:NI :

NI11ZR9 2 11 9
:NI:ZR :

NI7ZR2 2 7 2
:NI:ZR :

SC5SI3 2 0.625 0.375
:SC:SI :

SCSI 2 0.5 0.5
:SC:SI :

SC3SI5_LT 2 0.375 0.625
:SC:SI :

SC3SI5_HT 2 0.375 0.625
:SC:SI :

SCZN 2 0.5 0.5
:SC:ZN :

SCZN2 2 0.3333 0.6667
:SC:ZN :

SC13ZN58 2 0.1831 0.8169
:SC:ZN :

SC3ZN17 2 0.15 0.85
:SC:ZN :

SCZN12 2 7.7E-2 0.923
:SC:ZN :

SIB3 3 6 2 6
:B:SI:B SI :

SIB6 3 210 23 48
:B:SI:B SI :

SIBX 3 61 1 8
:B:SI:B SI :

SIC 2 1 1
:C:SI :

CR3SI 2 3 1
:CR SI:AL CR SI :

CRSI2_C40 2 1 2
:CR SI V:AL CR SI :

SI2SR_HT 2 2 1
:SI VA:SR :

SI2SR_LT 2 2 1
:SI:SR :

SI3TI5_D88 2 3 5
: SI : TI :

V3SI 2 0.75 0.25
:V SI:SI V :

CRZN13 2 1 13
:CR:ZN :

CRZN17 2 1 17
:CR:ZN :

SRZN5_LT 2 1 5
:SR:ZN :

TIZN2 2 1 2
:TI:ZN :

TIZN5 2 1 5
:TI:ZN :

TIZN10 2 1 10
:TI:ZN :

TIZN15 2 1 15
:TI:ZN :

V4ZN5 2 4 5
:V:ZN :

ZN2ZR 2 2 1
:ZN:ZR :

ZN22ZR 2 22 1
:ZN:ZR :

ZN39ZR5 2 39 5
:ZN:ZR :

ZN3ZR_LT 2 3 1
:ZN:ZR :

ZN3ZR_HT 2 3 1
:ZN:ZR :

B4C 2 1 1
:B11C B12:B2 C2B CB2 :

CR2B_ORTH 2 0.666667 0.333333
:CR:B :

CRB4 2 0.2 0.8
:CR:B :

SRB6 2 1 6
:SR:B :

V2B3 2 0.4 0.6
:V:B :

V5B6 2 0.454545 0.545455
:V:B :

ZRB12 2 12 1
:B:ZR :

CU6CE 2 6 1
:CU:CE :

CU5CE 2 5 1
:AL CU:CE :

CU4CE 2 4 1
:AL CU:CE :

CU2CE 2 2 1
:CU:CE :

CUCE 2 1 1
:CU:CE :

CE2FE17 2 2 17
:CE:AL FE :

MGCE 2 1 1
:AL MG:CE :

MG3CE 2 3 1
:MG:MG CE :

MG41CE5 2 41 5
:MG:CE :

MG17CE2 2 17 2
:MG:CE :

MG12CE 2 12 1
:AL MG:CE :

CE5SI3 2 3 5
:SI:CE :

CE3SI2 2 3 2
:CE:SI :

CE5SI4 2 5 4
:CE:SI :

CESI 2 1 1
:CE:SI :

CE3SI4 2 1 1.34
:CE:SI :

CE3SI5 2 0.37 0.63
:CE:SI :

CESI2 2 1 2
:CE:AL SI :

CE7NI3 2 0.7 0.3
:CE:NI :

CENI 2 0.5 0.5
:CE:NI :

CENI2 2 0.333333 0.666667
:CE NI:CE NI :

CENI3 2 0.25 0.75
:CE:AL NI :

CE2NI7 2 0.222222 0.777778
:CE:AL NI :

CENI5 2 0.166667 0.833333
:ER CE NI:AL CE CU NI :

CR3C2 2 3 2
:CR:C :

V3C2 2 3 2
:V:C :

CDCU2 2 1 2
:CD:CU :

CD3CU4 2 0.4286 0.5714
:CD:CU :

CD8CU5 4 2 3 2 6
:CU:CD CU:CU:CU CD :

CD10CU3 2 0.7692 0.2308
:CD:CU :

SN_HP1
:CD IN SN :

CR3GE 2 0.75 0.25
:CR GE:CR GE :

CR5GE3_HT 2 0.625 0.375
:CR GE:GE CR :

CR5GE3_LT 2 0.625 0.375
:CR GE:GE CR :

CR11GE19 2 0.367 0.633
:CR:GE :

GE2SR 2 2 1
:GE:SR :

GE3TI5 2 5 3
:TI:GE :

V3GE 2 0.75 0.25
:V:GE :

V17GE31 2 0.354 0.646
:V:GE :

SR3SN5 2 0.375 0.625
:SR:SN :

SRSN3 2 0.25 0.75
:SR:SN :

SRSN4 2 0.2 0.8
:SR:SN :

SN3TI2 2 3 2
:SN:TI :

V3SN 2 0.205 0.795
:SN:V :

VSN2 2 0.6 0.4
:SN:V :

SN3ZR5 3 5 3 1
:ZR:SN:SN VA :
> aka eta

SNZR3_A15 2 3 1
:SN ZR:SN ZR :

V2ZR 2 2 1
:V:ZR :

AL14CA13 2 14 13
:AL MG ZN:CA :

AL3CA8 2 3 8
:AL:CA MG :

AL4CE 2 0.8 0.2
:AL:CE :

AL11CE3 2 0.7857 0.2143
:AL MG:CE :

AL3CE_H 2 0.75 0.25
:AL:CE :

AL3CE_L 2 0.75 0.25
:AL SI:CE :

ALCE 2 0.5 0.5
:AL:CE :

ALCE2 2 0.3333 0.6667
:AL:CE :

ALCE3_H 2 0.25 0.75
:AL:CE :

ALCE3_L 2 0.25 0.75
:AL:CE :

AL13CO4 2 13 4
:AL:CO :

AL3CO 2 3 1
:AL:CO :

AL5CO2 2 5 2
:AL:CO :

AL9CO2 2 9 2
:AL:CO :

AL3LA 2 3 1
:AL:LA :

ALLA 2 1 1
:AL:LA :

AL53LA22 2 0.707 0.293

:AL:LA :

AL11LA3_LT 2 11 3
:AL:LA :

AL11LA3_HT 2 11 3
:AL:LA :

AL2LI3 2 2 3
:AL MG:LI :

ALLI2 2 1 2
:AL:LI :

AL4LI9 2 4 9
:AL:LI :

B32_ALLI 2 1 1
:AL LI MG:LI MG VA :

AL3X 2 1 3
:ER LI SC TI ZR:AL MG :
> Al3Sc (dissolving Ti, Zr), Al3Li

AL2SC 2 1 2
:SC TI ZR:AL :

ALSC 2 1 1
:SC ZR:AL :

AL3HF4 2 3 4
:AL:HF :

LI22SI5 2 22 5
:LI:SI :

LI13SI4 2 13 4
:LI:SI :

LI7SI3 2 7 3
:LI:SI :

LI12SI7 2 12 7
:LI:SI :

AG9CA2 2 0.818182 0.181818
:AG:CA :

AG7CA2 2 0.777778 0.222222
:AG:CA :

AG2CA 2 0.666667 0.333333
:AG:CA :

AGCA3 2 0.25 0.75
:AG:CA :

AG4SC 2 0.8 0.2
:AG:SC :

AGSC 2 0.5 0.5
:AG:SC :

AL4C4SI 3 4 1 4
:AL:SI:C :

AL8C7SI 3 8 1 7
:AL:SI:C :

AL20CECR2 3 0.869565 4.3478E-2 8.6957E-2
:AL:CE:CR :

AL8CEM4 3 0.6154 7.69E-2 0.3077
:AL:CE ER:AL CR CU FE MN :
> T1

AL10CE2M7 2 0.8947 0.1053
:AL CR CU FE MN:CE ER :
> T2

AL3CECU 2 0.8 0.2
:AL CU:CE :
> T3

ALCEM 3 0.3333 0.3333 0.3334
:AL:CE ER:CU NI :
> T4

ALCE2CU2 3 0.2 0.4 0.4
:AL:CE:CU :
> T5

ALCEFE 2 2 1
:AL FE:CE :

AL10CEFE2 3 10 1 2
:AL:CE ER:FE :

AL8CEFE2 3 8 1 2
:AL:CE:FE :

AL13CEMG6 3 0.667 5E-2 0.283
:AL:CE:MG :

AL2CENI 3 2 1 1
:AL:CE:NI :
> T2

AL5CE2NI5 3 0.35 0.165 0.485
:AL:CE:NI :
> T3, 13

AL4CENI 3 4 1 1
:AL:CE:NI :
> T5

AL5CE1NI2 3 5 1 2
:AL:CE:NI :
> T6

AL23CE4NI6 3 23 4 6
:AL:CE:NI :
> T8

AL60CE12NI28 3 0.6 0.12 0.28
:AL:CE:NI :
> T11

AL40CE30NI30 3 0.403 0.304 0.293
:AL:CE:NI :
> T12

ALCESI 2 2 1
:AL SI:CE :

AL7CE5SI3 3 0.49 0.333333 0.176667
:AL:CE:SI :

ALCESI2 3 1 1 2
:AL:CE:SI :

AL4CE3SI6 3 4 3 6

:AL:CE:SI :

AL13CR4SI4 3 13 4 4

:AL:CR:SI :

> Al-Cr-Si, tao 1

AL9CR3SI 3 9 3 1

:AL:CR:SI :

> Al-Cr-Si, tao 2

ALCRSI_T3 2 11 4

:AL SI:CR :

> Al-Cr-Si, tao 3

ALCRSI_T4 3 58 31.5 10.5

:AL:CR:SI :

> Al-Cr-Si, tao 4, AL58CR32SI11

AL9CU6ER5 3 0.45 0.3 0.25

:AL:CU:ER :

AL5CU3ER2 3 0.5 0.3 0.2

:AL:CU:ER :

AL3CU1ER1 3 0.6 0.2 0.2

:AL:CU:ER :

AL62CU25FE13 3 0.125 0.255 0.62

:FE:AL CU:AL :

AL7CU2FE 3 1 2 7

:FE NI:CU:AL :

> Solution phase of the ternary compound Al7Cu2Fe

AL10CU10FE 3 1 10 10

:FE:AL CU:AL :

AL2CULI 3 0.5 0.25 0.25

:AL:CU:LI :

> Al-Cu-Li ternary phase, i.e. T1

ALCULI_T2 3 0.57 0.11 0.32

:AL:CU:LI :

> Al-Cu-Li ternary phase, T2

ALCULI_R 3 0.55 0.117 0.333

:AL:CU:LI :

> Al-Cu-Li ternary phase, R

ALCULI_B 3 0.6 0.32 8E-2

:AL:CU:LI :

> Al-Cu-Li ternary phase, TB

Q_PHASE 3 7 3 6

:AL:CU:MG :

> Al7Cu3Mg6, Al-Cu-Mg ternary phase

S_PHASE 3 2 1 1

:AL SI:CU:MG :

> Solution phase based on Al2CuMg

S_PRIME 3 2 1 1

:AL:CU:MG :

> metastable precipitate, related to S_PHASE

T_PHASE 4 26 6 48 1

:MG:AL MG:AL CU MG ZN:AL :

> Solution (Al,Cu,Zn)49Mg32, stable in Al-Mg-Zn, Al-Cu-Mg, Al-Cu-Mg-Zn

AL28CU4MN7 3 28 7 4

:AL:MN:CU :

AL11CU5MN3 3 11 3 5
:AL:MN:CU :

ALCU3MN2 3 1 2 3
:AL:MN:CU :

AL7CU4NI 2 1 1
:AL:FE CU NI VA :

ALCUSC_TAU 3 0.6154 0.3077 7.69E-2
:AL CU:AL CU:SC :

AL6ER2FE11 3 6 2 11
:AL:ER:FE :

AL7ERMG2 3 0.66667 0.1 0.23333
:AL:ER:MG :

AL9FENI 2 9 2
:AL:FE NI :

AL10FE3NI 2 5 2
:AL:FE NI :

AL71FE5NI24 3 0.71 5E-2 0.24
:AL:FE:NI :

ALFESI_T1 2 5 3
:AL SI:FE :
> Al-Fe-Si ternary phase, tao 1 / tao 9

ALFESI_T2 4 0.5 0.2 0.1 0.2
:AL:FE:SI:AL SI :
> Al-Fe-Si ternary phase, tao 2, gamma_AlFeSi

ALFESI_T3 3 0.56 0.24 0.2
:AL:FE:SI :
> Al-Fe-Si ternary phase, AL56FE24SI10, tao 3

ALFESI_T4 4 0.4166 0.1667 0.25 0.1667
:AL:FE:SI:AL SI :
> Al-Fe-Si ternary phase, tao 4, delta_AlFeSi

AL8FE2SI 4 0.6612 0.19 4.96E-2 9.92E-2
:AL:FE:SI:AL SI :
> solution of the Al-Fe-Si ternary phase, tao 5, alpha_AlFeSi

AL9FE2SI2 4 0.598 0.152 0.1 0.15
:AL:FE:SI:AL SI :
> Al-Fe-Si ternary phase, tao 6, aka Al5FeSi, beta_AlFeSi

ALFESI_T7 2 3 1
:AL SI:FE :
> Al-Fe-Si ternary phase, AL9FE5SI6, tao 7

ALFESI_T8 2 2 1
:AL SI:FE :
> Al-Fe-Si ternary phase, AL2FE3SI4, tao 8

ALFESI_T10 3 0.6 0.25 0.15
:AL:FE:SI :
> Al-Fe-Si ternary phase, AL60FE25SI15, tao 10

ALFESI_T11 3 0.65 0.25 0.1
:AL:FE:SI :

> Al-Fe-Si ternary phase, AL85FE30SI15, tao 11

ALFEZN_GAMMA 2 0.255 0.745

:AL FE ZN:ZN :

> Al-Fe-Zn ternary phase, aka gamma 2, no detailed structure

ALLIMG_T 3 0.53 0.33 0.14

:AL:LI:MG :

ALLISI 3 0.333333 0.333333 0.333334

:LI:AL:SI :

AL3LI8SI5 3 0.5 0.1875 0.3125

:LI:AL:SI :

ALLI5SI2 3 0.6625 8.75E-2 0.25

:LI:AL:SI :

ALLI2ZR 3 1 2 1

:AL:LI:ZR :

AL18MG3MN2 3 18 3 2

:AL:MG:MN :

ALMG3NI2 3 1 2 3

:AL:NI:MG :

> Ternary phase AlMg3Ni2, cF96, Fd-3m, Ti2Ni type

BETA_PRIME 2 1.8 1

:MG:SI :

> metastable precipitate, Mg9Si5/Mg1.8Si, related to Mg2Si

B_PRIME 3 3 9 7

:AL:MG:SI :

> metastable precipitate, B_Prime, Al-containing Pre-beta phase

U1_AL2MGSI2 3 2 1 2

:AL:MG:SI :

> metastable precipitate, U1_Al2MgSi2, Al-containing Pre-beta phase

U2_AL4MG4SI4 3 1 1 1

:AL:MG:SI :

> metastable precipitate, U2_Al4Mg4Si4, Al-containing Pre-beta phase

BETA_DPRIME 3 2 5 4

:AL SI:MG:SI :

> metastable beta double prime, related to Mg2Si, Mg5Si6, Al2Mg5Si4

ETA_PRIME 3 3 2.5 3.5

:AL:MG:ZN :

> metastable precipitate, related to MgZn2-based Eta phase

T_PRIME 3 0.3 0.4 0.3

:AL:MG:ZN :

> metastable precipitate, related to T_PHASE

AL31MN6NI2 3 31 6 2

:AL:MN:NI :

> Orthorhombic, ternary Al-Mn-Ni phase

AL2MN2SI3 3 2 2 3

:AL:MN:SI :

> the Al-Mn-Si ternary phase, tao1

AL5MN6SI7 3 5 6 7
:AL:MN:SI :
> the Al-Mn-Si ternary phase, tao2

AL1MN1SI1 3 1 1 1
:AL:MN:SI :
> the Al-Mn-Si ternary phase, tao3

AL3MNSI2 3 3 1 2
:AL:MN:SI :
> the Al-Mn-Si ternary phase, tao4

AL3MN4SI2 3 3 4 2
:AL:MN:SI :
> the Al-Mn-Si ternary phase, tao5

ALMNSI_T6 2 4 1
:AL MN:SI :
> the Al-Mn-Si ternary phase, tao6

ALMNSI_T8 4 6 3 3 1
:AL:MN:AL MN SI:AL SI :
> the Al-Mn-Si ternary phase, tao 8

AL15SI2M4 4 16 4 1 2
:AL:FE MN:SI:AL SI :
> Solution of Al-Mn-Si ternary phase, tao 9, Al15(Mn,Fe)3Si2

AL2MNSI3 3 2 1 3
:AL:MN:SI :
> the Al-Mn-Si ternary phase, tao10

AL24MN5ZN 3 5 1 24
:MN ZN:ZN:AL :

AL9MN2ZN 3 2 1 9
:MN:ZN:AL :

AL11MN3ZN2 3 3 2 11
:MN:ZN:AL :

ALNI2SI 2 1 1
:AL SI VA:NI :

AL6NI3SI 3 6 3 1
:AL:NI:SI :

ALNI16SI9 3 1 16 9
:AL:NI:SI :

ALNI2ZN 3 0.25 0.5 0.25
:AL:NI:ZN :

AL13NI38ZN49 3 0.13 0.38 0.49
:AL:NI:ZN :
> Al-Ni-Zn ternary phase

ALSC2SI2 3 1 2 2
:AL:SC:SI :

ALSI3TI2 3 0.2 0.466667 0.333333
:AL SI:SI:TI :

ALSI7TI4 3 0.1 0.566667 0.333333
:AL SI:SI:TI :

CULIMG_T 3 1 8E-2 1.92
:CU:LI:MG :

CU16MG6SI7 3 16 6 7

:CU:MG:SI :

CU3MG2SI 3 2.74 2 1.26
:CU:MG:SI :

CU5MN4SI 3 0.5 0.37 0.13
:CU:MN:SI :

CUMNZN 3 0.334 0.333 0.333
:CU:MN:ZN :

CU6NISI3 2 0.732 0.268
:CU NI:SI :

CU46NI25SI29 3 0.458 0.25 0.292
:CU:NI:SI :

FE5NI3SI2 2 4 1
:FE NI:SI :

ZN13M2 2 1 6.5
:FE NI:ZN :

MG6MN3NI 3 0.5 0.1666667 0.3333333
:MG:MN:NI :

MGNI6SI6 3 1 6 6
:MG:NI:SI :

MG2NI3SI 3 2 3 1
:MG:NI:SI :

MG10NI55SI35 3 2 11 7
:MG:NI:SI :

MG2NI16SI11 3 1 8 5.5
:MG:NI:SI :

MG5NI9SI 3 1 1.8 0.2
:MG:NI:SI :

MG9NI29SI16 3 9 29 16
:MG:NI:SI :

MGNI6ZN6 4 3 4 1 2
:MG ZN:MG NI ZN:NI:ZN :

MN15NI45SI40 3 0.15 0.45 0.4
:MN:NI:SI :
> Mn-Ni-Si ternary phase, T1 or N

MN15NI50SI35 3 0.15 0.5 0.35
:MN:NI:SI :
> Mn-Ni-Si ternary phase, T2 or PHI

MN6NI16SI7 3 0.206897 0.551724 0.241379
:MN:NI:SI :
> Mn-Ni-Si ternary phase, T3 or G

MN1NI1SI1 3 1 1 1
:MN:NI:SI :
> Mn-Ni-Si ternary phase, T4 or E

MNNISI_T5 2 1 2
:MN:NI SI :
> Mn-Ni-Si ternary phase, T5 or "tao 1"

MNNISI_T6 2 1 2
:MN:NI SI :
> Mn-Ni-Si ternary phase, T6 or "tao 2"

MN3NI2SI 3 3 2 1
:MN:NI:SI :
> Mn-Ni-Si ternary phase, T7 or Omega

MN2NISI 2 3 1
:MN NI:SI :
> Mn-Ni-Si ternary phase, T8 or S

MN6NISI3 3 0.61 0.12 0.27
:MN:NI:SI :
> Mn-Ni-Si ternary phase, T9 or R

MN66NI4SI30 3 0.66 4E-2 0.3
:MN:NI:SI :
> Mn-Ni-Si ternary phase, T10 or U

MN52NI29SI19 3 0.52 0.29 0.19
:MN:NI:SI :
> Mn-Ni-Si ternary phase, T11 or W

MN7NI7ZN86 3 7E-2 7E-2 0.86
:MN:NI:ZN :

NI2SIZN_T1 3 0.5 0.25 0.25
:NI:SI:ZN :

NI9SI2ZN_T2 3 0.75 0.1675 8.25E-2
:NI:SI:ZN :

NI2SIZN3_T3 3 2 1 3
:NI:SI:ZN :

NISIZN_T4 3 3 2 1
:NI:SI:ZN :
> Ni-Si-Zn tao 4, Ni3Si2Zn1

Q_ALCUMGSI 4 5 2 8 6
:AL:CU:MG:SI :
> Quaternary phase, aka Q, Al5Cu2Mg8Si6, Al3Cu2Mg9Si7 & Al4Cu2Mg8Si7

AL18FE2MG7SI10 4 18 2 7 10
:AL:FE:MG:SI :
> Quaternary phase, aka Al8FeMg3Si6 and Q_/PHI/H_PHASE