TCS Solder Alloy Solutions Database (TCSLD5)

Technical Information

Available Starting with Thermo-Calc Version 2024b

Document created 2025-01-09

Contents

About the TCS Solder Alloy Solutions Database (TCSLD)

TCS Solder Alloy Solutions Database (TCSLD) is a thermodynamic database for applications to solder and brazing alloys. The database enables pre-screening of potential solder candidate compositions and predictions of various thermodynamic properties and phase equilibria.

The results from these predictions can be applied to eliminate candidate solder alloys for which the calculations reveal unsuitable freezing temperature ranges and undesired phases from further testing. Thus, the database can accelerate design of new solder alloys as well as improve understanding of existing solder alloys in terms of their processing and in-service behavior.

The database also provides information on possible interfacial reactions. that contains all the important solder alloy systems, e.g., Sn-/Au-/Bi-/Zn-based solders and Cu, Ni, Pd and so on and the relevant substrate or metallization materials.

In addition to thermodynamic data, it has properties data available for:

- Molar volume with thermal expansion coefficients
- Electrical resistivity
- Thermal conductivity
- Viscosity of metallic liquids
- Surface tension of metallic liquids

The database is validated where possible against commercial solder alloys and available experimental information.

TCSLD: TCS Solder Alloy Solutions Database Revision History. The current version of the database is TCSLD5. See the link for any subversion release details.

The database is compatible with the TCS Solder Alloy Solutions Mobility Database (MOBSLD). The current version is MOBSLD2.

The CALPHAD Method

The Thermo-Calc databases are developed with the CALPHAD approach based on various types of experimental data and theoretical values (e.g. those from first-principles calculations). It is based on the critical evaluation of binary, ternary, and for some databases, important higher order systems. This enables predictions to be made for multicomponent systems and alloys of industrial importance. Among these, the thermodynamic database is of fundamental importance.

For more learning resources about CALPHAD and our databases, visit the video tutorials on our website or our YouTube playlist.

Learn more on our website about the CALPHAD Method and how it is applied to the Thermo-Calc databases.

Use Case Examples

There are examples available to both demonstrate the *validation* of the database and to showcase the types of *calculations* that can be used for different materials or application area.

A range of properties can easily be calculated with TCSLD5, including:

- Liquidus and solidus temperatures as a function of compositions.
- Isothermal or vertical section phase diagrams.
- Phase formation, phase fractions and phase compositions.
- Thermodynamic driving force for the formation of intermetallic compounds (IMCs).
- Predict non-equilibrium solidification behavior of solder alloys. This can be at specific cooling rates when using the 'Back diffusion in primary phase' option with the Scheil Calculator.

By using the Diffusion Module (DICTRA) in conjunction with a suitable mobility database, diffusion-controlled interface reactions during the soldering process can be simulated so that the reliability of solder joints can be predicted to a certain extent, for example to:

- Predict the growth of intermetallic compounds
- Simulate the dissolution of substrate

Combining Databases

It is possible to combine several databases to make calculations using Thermo-Calc. For more information related to a specific type of problem, contact one of our support specialists at info@thermocalc.com. The experts are available to make recommendations on the most suitable database to use for your needs.

TCS Solder Alloy Solutions Database (TCSLD) Resources

Information about the database is available on our website and in the Thermo-Calc software online Help.

- **Website**: On our website the information is both searchable and the database specific PDFs are available to download.
- **Online Help**: Technical database information is included with the Thermo-Calc software online Help. When in Thermo-Calc, press F1 to search for the same information as is contained in the PDF documents described. Depending on the database, there are additional examples available on the website.

Database Specific Documentation

- The *TCS Solder Alloy Solutions Database (TCSLD) Technical Information* PDF document contains version specific information such as the binary and ternary assessed systems, phases and models. It also includes details about the properties data (e.g. viscosity, surface tension, etc.), a list of the included elements, and summaries of the database revision history by version.
- The *TCS Solder Alloy Solutions Database (TCSLD) Validation and Calculation Examples Collection* PDF document contains a series of validation examples using experimental data, and a set of calculation examples showing some of the ways the database can be used.

Go to the Solder Alloys Databases page on our website where you can access a Validation and Calculation Examples Collection and the Technical Information plus learn more about the compatible kinetic database. Also explore further applications of Thermo-Calc to solders including links to resources such as examples, publications, and more.

Learn more on our website about the CALPHAD Method and how it is applied to the Thermo-Calc databases.

TCSLD5 Elements, Systems, Phases, and Properties Data

Included Elements

There are 24 elements included in the most recent version of the database.

Included ELements									
Ag	Al	Au	Bi	Ca	Cd	Co	Cu	Ga	Ge
Hf	In	Mg	Mn	Ni	Pb	Pd	Pt	Sb	Si
Sn	Ti	Zn	Zr						

Assessed Systems and Phases

The most recent version of the database contains:

- 161 binary systems, which can be calculated with the BINARY module in Thermo-Calc Console Mode.
- 78 ternary systems, which can be calculated with the TERNARY module in Thermo-Calc Console Mode.
- 328 solution and intermetallic phases, which covers all the important solder alloy phases.

In most cases, the phases having the same crystal structure are merged as the same phase.

In Console Mode, you can list phases and constituents in the Database (TDB) module and the Gibbs (GES) module. For some phases, supplementary information is included in the definitions. To show the information, it is recommended in the Database (TDB) module to use the command LIST_SYSTEM with the option `Constituents`.

Properties Data

For more information about the various thermophysical, thermomechanical, and properties models, and when in Thermo-Calc, press F1 to search the online help. The details are found under a *General Reference* section.

You can find information on our website about the properties that can be calculated with Thermo-Calc and the Add-on Modules. Additional resources are added on a regular basis so keep checking back or subscribe to our newsletter.

Below is a summary of the available parameters and variables for the databases when working in Thermo-Calc. There are differences when you are working in Console Mode versus Graphical Mode as well as if you use an SDK such as TC-Python or TC-Toolbox for MATLAB®.

Property (and Graphical Mode Variable Name)	*Model Parameters*	*Variables to Show or Plot in Console Mode or the SDKs (TC-Python, or TC-Toolbox for MATLAB®)****
Molar volume	V0, VA	VM for a system `VM(PHI)` for phase PHI
Electrical conductivity	ELQ**	ELCD for a system `ELCD(PHI)` for phase PHI
Electrical resistivity	ELRS, ESPD	ELRS for a system `ELRS(PHI)` for a phase PHI
Thermal conductivity	THCD	THCD for a system `THCD(PHI)` for phase PHI
Thermal resistivity		THRS for a system `THRS(PHI)` for phase PHI
Thermal diffusivity		THDF for a system `THDF(PHI)` for phase PHI
Surface tension	SIGM, XI*	`SURF(LIQUID)` `SURF(ION)` **
Dynamic viscosity	VISC	`DVIS(LIQUID)` `DVIS(ION)` **
Kinematic viscosity		`KVIS(LIQUID)` `KVIS(ION)` **

* XI is not used in the TCOX database (all versions). As of 2023b it is also not used starting with the following versions of these databases: TCFE13, TCNI12.1, TCTI5.1, TCNOBL3, TCPMAG2, and TCCU6. As of 2024a, TCMG7, TCAL9, and TCHEA7. As of 2024b, TCSLD5.

** `ION` is used in the TCS Metal Oxide Solutions Database (TCOX)

*** The examples listed for the SDKs are using Console Mode syntax. The quantities can also be accessed in both `ThermodynamicQuantity` and `ScheilQuantity` classes. See the various model descriptions or the SDK help for details.

TCSLD5 Systems

In this section:

TCSLD5 Assessed Binary Systems

Low temperature ordered phases are not fully included in Au-Cu, Co-Pt, Cu-Pd, Cu-Pt, Ni-Pt.

	Ag	Al	Au	Bi	Ca	Cd	Co	Cu	Ga	Ge	Hf	In	Mg	Mn	Ni	Pb	Pd	Pt	Sb	Si	Sn	Ti	Zn	Zr
Ag	Ag																							
Al	x	Al																						
Au	x	x	Au																					
Bi	x	x	x	Bi																				
Ca		x			Ca																			
Cd						Cd																		
Co	x	x	x	x			Co																	
Cu	x	x	x	x		x	x	Cu																
Ga	x	x		x				x	Ga															
Ge	x	x	x	x			x	x	x	Ge														
Hf	x							x	x		Hf													
In	x	x	x	x			x	x	x	x		In												
Mg		x		x					x				Mg											
Mn				x				x						Mn										
Ni	x	x	x	x			x	x		x		x			Ni									
Pb	x	x	x	x	x	x	x	x		x		x	x		x	Pb								
Pd	x	x	x	x			x	x				x			x	x	Pd							
Pt	x	x	x	x			x	x	x	x		x			x	x		Pt						
Sb	x	x	x	x		x	x	x	x	x		x			x	x	x	x	Sb					
Si	x	x	x	x			x	x		x		x			x	x	x	x	x	Si				
Sn	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	Sn			
Ti	x							x	x		x	x									x	Ti		
Zn	x	x	x	x		x	x	x	x	x		x	x		x	x	x		x	x	x		Zn	
Zr	x							x	x		x	x									x	x		Zr

TCSLD5 Assessed Ternary Systems

In the table, * indicates low temperature ordered phases are not included.

Assessed Ternary Systems					
Ag-Al-Cu	Ag-Au-Bi	Ag-Au-Cu*	Ag-Au-Ge	Ag-Au-Ni	Ag-Au-Pb
Ag-Au-Sb	Ag-Au-Si	Ag-Au-Sn	Ag-Bi-Cu	Ag-Bi-In	Ag-Bi-Sb
Ag-Bi-Sn	Ag-Cu-Ga	Ag-Cu-In	Ag-Cu-Pb	Ag-Cu-Pd	Ag-Cu-Sn
Ag-Cu-Ti	Ag-Cu-Zn	Ag-Cu-Zr	Ag-In-Pd	Ag-In-Sb	Ag-In-Sn
Ag-Ni-Sn	Ag-Sb-Sn	Ag-Sb-Zn	Ag-Sn-Zn	Al-Bi-Sn	Al-Bi-Zn
Al-Cu-Sn	Al-Cu-Zn	Al-Ga-Zn	Al-Ge-Zn	Al-Mg-Zn	Al-Pb-Sn
Al-Sn-Zn	Au-Bi-Sb	Au-Bi-Sn	Au-Co-Sn	Au-Cu-Sb*	Au-Ge-Sn
Au-In-Sb	Au-In-Sn	Au-Ni-Sn	Au-Pb-Sn	Au-Pt-Sn	Au-Sb-Sn
Au-Si-Sn	Bi-Cu-Sb	Bi-Cu-Sn	Bi-In-Pb	Bi-In-Sn	Bi-Pb-Sn
Bi-Sb-Sn	Bi-Sn-Zn	Ca-Pb-Sn	Cd-Pb-Sn	Cd-Sb-Zn	Co-Ni-Sb
Cu-In-Sn	Cu-Mn-Sn	Cu-Ni-Pb	Cu-Ni-Sn	Cu-Pb-Sn	Cu-Si-Zn
Cu-Sn-Ti	Cu-Sn-Zn	Cu-Ti-Zr	Ga-Ge-Pt	Ga-Sn-Zn	Ge-Sb-Sn
In-Ni-Sn	In-Pb-Sn	In-Sb-Sn	In-Sn-Zn	Pb-Sb-Sn	Pb-Sn-Zn

TCSLD5 Phases

In this section:

Common Phases for the Solder Alloys

The following lists common phase names and the corresponding Thermo-Calc database phase names for some key solder systems.

Name in the Database	*Common Name and Description*
FCC_A1	Substrate material such as copper, nickel, silver, palladium
CU6SN5_HT_NIAS	Cu6Sn5, or η phase, a common intermetallic compoud which forms at the solder/substrate interface.
CU3SN	Cu3Sn, or ε phase, a common intermetallic compoud which forms at the solder/substrate interface.
NI3SN4	Ni3Sn4, a common intermetallic compoud which forms at the interface between solder alloy and Ni substrate.

TCSLD5 Models for the Included Phases

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
GAS	Gas					1	(AG, AG1/+1, AG1AL1, AG1AU1, AG1CU1, AG2, AL, AL1/+1, AL1/-1, AL1AU1, AL1CU1, AL1SB1, AL2, AU, AU1/+1, AU1/-1, AU1CO1, AU1CU1, AU1SI1, AU2, BI, BI1/+1, BI2, BI3, BI4, CA, CA1/+1, CA2, CD, CD1/+1, CO, CO1/+1, CO1/-1, CO2, CU, CU1/+1, CU1/-1, CU2, E-, GA, GA1/+1, GA1/-1, GA2, GE, GE1/+1, GE2, HF, IN, IN1/+1, IN1SB1, IN1SB2, IN2, MG, MG1/+1, MG2, MN, MN1/+1, NI, NI1/+1, NI1/-1, NI2, PB, PB1/+1, PB1/-1, PB2, PD, PD1/+1, PT, PT1/+1, PT1/-1, SB, SB1/+1, SB1/-1, SB2, SB3, SB4, SI, SI1/+1, SI1/-1, SI2, SI3, SN, SN1/+1, SN2, TI, TI2, ZN, ZN1/+1, ZN1/-1, ZR, ZR2)1.0
LIQUID	Liquid					1	(AG, AL, AU, BI, BI2MG3, CA, CA2PB, CA2SN, CD, CO, CU, GA, GE, HF, IN, MG, MG2PB1, MG2SN1, MN, NI, PB, PD, PT, PTSN, SB, SI, SN, TI, ZN, ZR)1.0
FCC_A1	Face-Centered Cubic (Cu, A1, fcc)	A1	cF4	(225, Fm-3m)		2	(AG, AL, AU, BI, CA, CD, CO, CU, GA, GE, HF, IN, MG, MN, NI, PB, PD, PT, SB, SI, SN, TI, ZN, ZR)1.0(VA)1.0
FCC_L12	Bogdanovite (Cu3Au, L12)	L12	cP4	(221, Pm-3m)		3	(AG, AL, AU, BI, CA, CD, CO, CU, GA, GE, HF, IN, MG, MN, NI, PB, PD, PT, SB, SI, SN, TI, ZN, ZR)0.75(AG, AL, AU, BI, CA, CD, CO, CU, GA, GE, HF, IN, MG, MN, NI, PB, PD, PT, SB, SI, SN, TI, ZN, ZR)0.25 (VA)1.0
BCC_A2	Body-Centered Cubic (W, A2, bcc)	A2	cI2	(229, Im-3m)		2	(AG, AL, AU, BI, CA, CO, CU, GA, GE, HF, IN, MN, NI, PB, PD, PT, SB, SI, SN, TI, VA, ZN, ZR)1.0(VA)3.0
BCC_B2	CsCl (B2)	B2	cP2	(221, Pm-3m)		3	(AG, AL, AU, BI, CA, CO, CU, GA, GE, HF, IN, MN, NI, PB, PD, PT, SB, SI, SN, TI, VA, ZN, ZR)0.5(AG, AL, AU, BI, CA, CO, CU, GA, GE, HF, IN, MN, NI, PB, PD, PT, SB, SI, SN, TI, VA, ZN, ZR)0.5(VA)3.0
CBCC_A12	alpha-Mn (A12)	A12	cI58	(217, I-43m)		2	(CU, MN, NI, SI, SN)1.0(VA)1.0
CUBIC_A13	beta-Mn (A13)	A13	cP20	(213, P4_132)		1	(AG, AL, CO, CU, MN, NI, SI, SN)1.0
BCT_A5	beta-Sn (A5)	A5	tI4	(141, I4_ 1/amd)		1	(AG, AL, BI, CD, CU, GA, IN, NI, PB, SB, SI, SN, ZN)1.0
HCP_A3	Hexagonal Close Packed	A3	hP2	(194, P6_		2	(AG, AL, AU, BI, CD, CO, CU, GA, GE, HF, IN, MG, NI, PB, PD, PT,

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
	(Mg, A3, hcp)			3/mmc)			SB, SI, SN, TI, ZN, ZR)1.0(VA)0.5
DIAMOND_A4	Diamond (A4)	A4	cF8	(227, Fd-3m)		1	(AG, AU, GA, GE, SB, SI, SN)1.0
ORTHORHOMBIC_GA	alpha-Ga (A11)	A11	oS8	(64, Cmce)		1	(GA)1.0
RHOMBOHEDRAL_A7	alpha-As (A7)	A7	hR2	(166, R-3m)		1	(AG, AU, BI, GE, IN, PB, SB, SN, ZN)1.0
TETRAGONAL_A6	In (A6)	A6	tI2	(139, I4/mmm)		1	(AL, BI, GA, IN, PB, SB, SN, ZN)1.0
AG2GA	Mg2In		hP9	(189, P-62m)		2	(AG)2.0(AG, GA, VA)1.0
AG3GA2	Unknown Structure					2	(AG)3.0(GA)2.0
AG1HF1	gamma-CuTi (B11)	B11	tP4	(129, P4/nmm)		2	(AG)1.0(HF)1.0
AL2CU_C16	Khatyrkite (Al2Cu, C16)	C16	tI12	(140, I4/mcm)	AgIn2, Al2Cu, AuPb2, CoSn2, MnSn2, Pb2Pd	2	(AG, AL, AU, CO, CU, GA, MN, PD)0.33333(AL, HF, IN, MN, PB, SN)0.66667
CU5ZN8_GAMMA_D82	gamma-brass (Cu5Zn8, D82)	D82	cI52	(217, I-43m)	Ag9In4, Ag5Zn8, Al4Cu9, Cu5Zn8, In7Ni3, Ni5Zn8	3	(AG, AL, IN, NI, SI, ZN)4.0(AG, AL, CU, IN, NI, SI, ZN)1.0(AG, CU, IN, SN, ZN)8.0
AG15PT17	Unknown Structure					2	(AG)0.46875(PT)0.53125
AG3SB_LT_CU3TI	Unknown Structure				Metastable AG3SB_LT (Cu3Ti structure) phase	2	(AG, SB)0.75(AG, SB)0.25
AG3SN_L60_CU3TI	beta-TiCu3 (D0a)	D0a	oP8	(59, Pmmn)	Ag3Sb, Ag3Sn, Au3In, Cu3Sb, Ni3Sb, Tao 1 in Cu-Ni-Sn	2	(AG, AU, CO, CU, NI, SB, ZN)0.75(AG, AU, BI, IN, NI, SB, SN)0.25
MTI2_C11B	MoSi2 (C11b)	C11b	tI6	(139, I4/mmm)		2	(AG, CU)1.0(TI, ZR)2.0
AGZN_ZETA	zeta-AgZn (Bb)	Bb	hP9	(147, P-3)		1	(AG, PB, SN, ZN)1.0

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
AL2AU_C1_CAF2	Fluorite (CaF2, C1)	C1	cF12	(225, Fm-3m)	Al2Au, Al2Pt, AuIn2, CoSi2, Ga2Pt, In2Pt, Mg2Pb, Mg2Sn, NiSi2, PtSn2	2	(AG, AL, AU, CU, GA, GE, IN, MG, SB, SI, SN)0.66667(AL, AU, CO, NI, PB, PT, SN)0.33333
ALAU_B31	AlAu		mP8	(11, P2_1/m)	AlAu, NiGe, GePt, NiSi, PdSi, PdSn, PtSi	2	(AL, GA, GE, PD, SI, SN)0.5(AU, CU, NI, PD, PT, VA)0.5
ALAU2_HT	MoSi2 (C11b)	C11b	tI6	(139, I4/mmm)		2	(AL, AU)1.0(AL, AU)2.0
ALAU2_LT	AlAu2		oP12	(62, Pnma)		2	(AL)1.0(AL, AU, CU)2.0
ALAU4_HT	Body-Centered Cubic (W, A2, bcc)	A2	cI2	(229, Im-3m)		2	(AL, AU)1.0(AU)4.0
ALAU4_LT	AlAu4		cP20	(198, P2_13)		2	(AL)0.2(AG, AU)0.8
AL3AU8	Yb8In3		hR132	(167, R-3c)		2	(AL)0.27273(AU)0.72727
AL4CA	Al4Ba (D13)	D13	tI10	(139, I4/mmm)		2	(AL)4.0(CA)1.0
AL14CA13	Al14Ca13		mS54	(12, C2/m)		2	(AL)14.0(CA)13.0
AL3CA8	Ca8In3		aP22	(2, P-1)		2	(AL)3.0(CA)8.0
AL13CO4	Orthorhombic Co4Al13		oP102	(31, Pmn2_1)		2	(AL)13.0(CO)4.0
AL3CO	Os4Al13		mS34	(12, C2/m)		2	(AL)3.0(CO)1.0
AL5CO2_D811	Co2Al5 (D811)	D811	hP28	(194, P6_3/mmc)		2	(AL)5.0(CO)2.0
AL9CO2	Co2Al9 (D8d)	D8d	mP22	(14, P2_1/c)		2	(AL)9.0(CO)2.0
ALCU_GAMMA_HT	gamma-brass (Cu5Zn8, D82)	D82	cI52	(217, I-43m)	Al4Cu9	3	(AL, ZN)4.0(AL, CU, ZN)1.0(AG, CU)8.0

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
ALCU_ETA	AlCu(r)		mS20	(12, C2/m)		2	(AL, CU)0.5(AG, CU, ZN)0.5
CU6SN5_HT_NIAS	Ni2In (B82)	B82	hP6	(194, P6_ 3/mmc)	AlCu_D81, AuSn_Delta, BiNi, CoSb_Beta, Co3Sn2, Cu2In_HT, Cu6Sn5_HT, Ge3Ni5_ HT, InNi2_HT, Mn(2-x)Sn, NiSb, Ni3Si2_HT, Ni3Sn2, Pb3Pd5_ Gamma, PbPt, PdSb, Pd2Sn_HT, PtSn	3	(AG, AU, CO, CU, MN, NI, PD, PT, VA)1.0(AG, AL, BI, CU, GE, IN, NI, PB, SB, SI, SN)1.0(CO, CU, MN, NI, PD, VA)1.0
ALCU_ZETA	Al9Cu11(h)		oF88	(42, Fmm2)	AlCu_Zeta, Cu11In9	2	(AG, CU)0.55(AL, IN)0.45
AL2CU3_DELTA	Ni2In (B82)	B82	hP6	(194, P6_ 3/mmc)		2	(AL)0.4(AG, CU)0.6
ALMG_BETA	Al45Mg28		cF1832	(227, Fd-3m)		2	(MG)89.0(AL, ZN)140.0
ALMG_GAMMA	alpha-Mn (A12)	A12	cI58	(217, I-43m)		3	(MG)5.0(AL, MG, ZN)12.0(AL, MG, ZN)12.0
ALMG_EPS	Al30Mg23		hR53	(148, R-3)		2	(MG)23.0(AL, ZN)30.0
AL3NI2_D513	Al3Ni2 (D513)	D513	hP5	(164, P-3m1)	Al3Ni2, Al3Pd2, Al3Pt2, Au3In2, Ga3Pt2, In3Ni2, In3Pd2, In3Pt2	3	(AG, AL, AU, GA, GE, IN, PD, SN)0.6(AL, AU, IN, NI, PD, PT)0.4(IN, NI, VA)0.2
AL3NI_D011	Cementite (Fe3C, D011)	D011	oP16	(62, Pnma)	Al3Ni, Pd3Si, Pt3Si_HT	2	(AL, PD, PT)0.75(NI, SI)0.25
AL3NI5	Ga3Pt5		oS16	(65, Cmmm)		2	(AL)0.375(NI)0.625
AL21PT8_TI116	Al21Pt8		tI116	(88, I4_1/a)	Al21Pd8, Al21Pt8	2	(AL)21.0(PD, PT)8.0
AL2PD5	Ga2Pd5		oP28	(62, Pnma)		2	(AL)2.0(AL, PD)5.0
AL3PD	(Al3Pd)		oP*	(33, Pna2_1)		2	(AL)3.0(PD)1.0
ALPD	CsCl (B2)	B2	cP2	(221, Pm-3m)		2	(AL, PD)1.0(PD, VA)1.0

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
AL3PD5_OP16	Rh5Ge3		oP16	(55, Pbam)	Al3Pd5, Al3Pt5, In3Pd5	2	(AL, IN)3.0(PD, PT)5.0
AL4PD	(Al4Pd)		hP*	(182, P6_322)		2	(AL)4.0(PD)1.0
CO2SI_C23	Cotunnite (PbCl2, C23)	C23	oP12	(62, Pnma)	AlPd2, AlPt2, Ca2Sn, Co2Si, InPd2, Ni2Si, Pd2Sn, Pd2Zn	2	(AL, CO, IN, PB, PD, SI, SN, ZN)1.0(AL, CA, CO, NI, PD, PT, SI)2.0
AL21PT5	Li21Si5		cF416	(216, F-43m)		2	(AL)0.80769(PT)0.19231
COSI_B20	FeSi (B20)	B20	cP8	(198, P2_13)	AlPt, CoSi	2	(AL, CO, SI)0.5(CO, PT, SI)0.5
INSB_CF8	Zincblende (ZnS, B3)	B3	cF8	(216, F-43m)	AlSb, InSb	2	(AL, AU, IN)0.5(SB)0.5
C15_LAVES	Cu2Mg Cubic Laves (C15)	C15	cF24	(227, Fd-3m)	Au2Bi, Au2Pb, Al2Ca	2	(AG, AL, AU, CA, CU)0.66667(AL, BI, CA, CU, PB)0.33333
AU9IN4_GAMMA_D83	Au6(Au0.5In0.5)6In		cP76	(215, P-43m)		4	(AU, CU)0.61539(AL, AU, CU, IN)0.07692(AL, AU, CU, IN, SI)0.23077(AL, IN, SI, SN)0.07692
AUIN_BETA	Unknown Structure					2	(AU)0.785(IN)0.215
AUIN_BETA_PRIME	Cu10Sb3		hP26	(176, P6_3/m)		2	(AU)0.77778(IN)0.22222
AU7IN3	Au7In3		hP60	(147, P-3)		2	(AU)0.7(IN)0.3
AUIN	Unknown Structure					2	(AU)0.5(IN, SB, SN)0.5
AU10SN_D024	Ni3Ti (D024)	D024	hP16	(194, P6_3/mmc)	AuIn_Alpha1, AuSn_Beta	1	(AU, GE, IN, SN)1.0
AUPB3	alpha-V3S		tI32	(121, I-42m)		2	(AU)0.25(PB)0.75
AUSB2_C2	Pyrite (FeS2, C2)	C2	cP12	(205, Pa-3)	AuSb2, CoSb2, NiSb2, PdSb2	2	(AU, CO, NI, PD)0.33333(BI, IN, SB, SN)0.66667
AUSN2_OP24	AuSn2		oP24	(61, Pbca)	AuSn2, Bi2Pt	2	(AU, CU, PT)0.33333(BI, SN)0.66667
AUSN_ZETA_PRIME	Au5Sn		hR18	(155, R32)		2	(AU)0.84(IN, SN)0.16

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
AUSN4_OS20	PtSn4		oS20	(68, Ccce)	AuSn4, PdSn4, PtSn4	2	(AU, CU, NI, PD, PT)0.2(IN, PB, PD, SN)0.8
AU5ZN8_GAMMA	Cr4.5(Cr0.56Al0.44)9Al12		hR78	(160, R3m)		4	(AU, NI, ZN)2.0(AU, NI, SN, ZN)2.0(AU, NI, SN, ZN)3.0(SN, ZN)6.0
EPSILON_HCP	Hexagonal Close Packed (Mg, A3, hcp)	A3	hP2	(194, P6_ 3/mmc)	AuZn9	1	(AG, AU, CU, ZN)1.0
AU3ZN_ALPHA1	MgAg3		cP4	(221, Pm-3m)		3	(AU)3.0(AU, ZN)1.0(ZN)1.0
AU3ZN_ALPHA2	Au3Zn		oS32	(64, Cmce)		2	(AU)0.75(ZN)0.25
AU4ZN_ALPHA3	Unknown Structure					3	(AU)18.0(AU, ZN)7.0(ZN)3.0
AUZN3_GAMMA2	UH3		cP32	(221, Pm-3m)		2	(AU)1.0(ZN)3.0
AUZN4_GAMMA3	Unknown Structure					3	(AU)0.12(AU, ZN)0.16(ZN)0.72
AU5ZN3	Au5Zn3		oI128	(72, Ibam)		2	(AU)5.0(ZN)3.0
AU11ZN14	Unknown Structure					2	(AU)11.0(ZN)14.0
AUZN	CsCl (B2)	B2	cP2	(221, Pm-3m)		2	(AU, ZN)0.5(AU, ZN)0.5
AU15ZN85_EPSILON_ PRIME	Unknown Structure					2	(AU)0.15(ZN)0.85
BI3IN5_D8L	Cr5B3 (D8l)	D8l	tI32	(140, I4/mcm)		2	(IN)0.625(BI, SN)0.375
BIIN2_HP6	Ni2In (B82)	B82	hP6	(194, P6_ 3/mmc)	BiIn2, InNi2_RT	3	(IN, NI)1.0(IN, NI, SN)1.0(BI, IN, SN)1.0
BIIN_B10	Litharge (PbO, B10)	B10	tP4	(129, P4/nmm)		2	(BI, SN, TI)0.5(IN)0.5
BI2MG3_HT	Bixbyite (Mn2O3, D53)	D53	cI80	(206, Ia-3)		3	(BI)1.0(BI, VA)3.0(MG)6.0
BI2MG3_LT	La2O3 (D52)	D52	hP5	(164, P-3m1)	Bi2Mg3, P-3m1, La2O3-type (rt)	2	(BI, VA)2.0(MG)3.0

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
BIMN_LT	NiAs (B81)	B81	hP4	(194, P6_3/mmc)		2	(BI)0.5(MN)0.5
BIMN_HT	Mn2.23Bi1.88		oP10	(51, Pmma)		2	(BI)0.481(MN)0.519
INSN_A6	In (A6)	A6	tI2	(139, I4/mmm)		1	(BI, IN, PB, SB, SN)1.0
BI3NI	Bi3Ni		oP16	(62, Pnma)		2	(BI)0.75(NI)0.25
BI2PD	PdBi2		mS12	(12, C2/m)		2	(BI)0.666(PD)0.334
BIPD	alpha-BiPd		mP16	(4, P2_1)		2	(BI)0.5(PD)0.5
BI3PD5	Unknown Structure					2	(BI, PD)1.0(VA)1.0
BIPD3	Pd8Sb3		hR44	(161, R3c)		2	(BI)0.25(PD)0.75
BI3PT2	NiAs (B81)	B81	hP4	(194, P6_3/mmc)		2	(BI)3.0(PT)2.0
BIPT	NiAs (B81)	B81	hP4	(194, P6_3/mmc)		2	(BI)1.0(PT)1.0
CA5PB3	Ca5Pb3		hP48	(186, P6_3mc)		2	(CA)0.625(PB)0.375
CAPB	CuAu (L10)	L10	tP2	(123, P4/mmm)		2	(CA)0.5(PB)0.5
CAPB3	Bogdanovite (Cu3Au, L12)	L12	cP4	(221, Pm-3m)		2	(CA)0.25(PB, SN)0.75
CA5SN3	Cr5B3 (D8l)	D8l	tI32	(140, I4/mcm)		2	(CA)0.625(SN)0.375
CA36SN23	Sn23Yb36		tP118	(127, P4/mbm)		2	(CA)0.61(SN)0.39
CA31SN20	Pu31Rh20		tI204	(140, I4/mcm)		2	(CA)0.608(SN)0.392

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
CA7SN6	Ca7Sn6		oP52	(62, Pnma)		2	(CA)0.53846(SN)0.46154
CASN	CrB (B33)	B33	oS8	(63, Cmcm)		2	(CA)0.5(SN)0.5
CASN3	Bogdanovite (Cu3Au, L12)	L12	cP4	(221, Pm-3m)		2	(CA)0.25(PB, SN)0.75
CDCU2	MgZn2 Hexagonal Laves (C14)	C14	hP12	(194, P6_ 3/mmc)		2	(CD)1.0(CU)2.0
CD3CU4	Cd3Cu4		cF1124	(216, F-43m)		2	(CD)0.4286(CU)0.5714
CD8CU5	gamma-brass (Cu5Zn8, D82)	D82	cI52	(217, I-43m)		4	(CU)2.0(CD, CU)3.0(CU)2.0(CD, CU)6.0
CD10CU3	Co2Al5 (D811)	D811	hP28	(194, P6_ 3/mmc)		2	(CD)0.7692(CU)0.2308
CD3SB2	Unknown Structure				Metastable phase Cd3Sb2	2	(CD)3.0(SB)2.0
CO3GE	Cr3Si (A15)	A15	cP8	(223, Pm-3n)		2	(CO)0.75(GE)0.25
CO5GE2	Unknown Structure					2	(CO)0.714(GE)0.286
CO5GE3	Co2Si (C37)	C37	oP12	(62, Pnma)		3	(CO, VA)0.125(CO)0.5(CO, GE)0.375
CO5GE3_ALPHA	Unknown Structure					2	(CO)0.625(GE)0.375
CO5GE7	Co5Ge7		tI24	(107, I4mm)		2	(CO)0.417(GE)0.583
COGE	CoGe		mS16	(12, C2/m)		2	(CO, GE)0.5(CO, GE)0.5
COGE2	CoGe2		oS24	(64, Cmce)		2	(CO)0.333(GE)0.667
COIN2	Mg2Cu (Cb)	Cb	oF48	(70, Fddd)		2	(CO)1.0(IN)2.0
COIN3	In3Ir		tP16	(136, P4_ 2/mnm)		2	(CO)1.0(IN)3.0

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
COSB3_DELTA	Skutterudite (CoAs3, D02)	D02	cI32	(204, Im-3)		2	(CO, NI)0.25(SB)0.75
CO3SI_HT	Ni3Sn (D019)	D019	hP8	(194, P6_ 3/mmc)		3	(CO, CU, NI, SB, SI, SN)0.25(CO, CU, NI, SN)0.25(CO, CU, NI)0.5
CO2SI_HT	Co2Si (C37)	C37	oP12	(62, Pnma)		2	(CO, SI)0.6667(CO, SI)0.3333
COSN_HP6	CoSn (B35)	B35	hP6	(191, P6/mmm)	CoSn, InNi	2	(CO, NI)0.5(IN, SN)0.5
COSN3_OS32	PdSn3		oS32	(64, Cmce)	CoSn3, PdSn3	2	(CO, PB, PD)0.25(PD, SN)0.75
COZN_LT	beta-Mn (A13)	A13	cP20	(213, P4_132)		2	(CO, ZN)1.0(VA)1.0
COZN_HT	Body-Centered Cubic (W, A2, bcc)	A2	cI2	(229, Im-3m)		2	(CO, ZN)1.0(VA)1.0
COZN_GAMMA	gamma-brass (Cu9Al4, D83)	D83	cP52	(215, P-43m)		2	(CO, ZN)1.0(VA)1.0
COZN_DELTA	Unknown Structure					2	(CO)0.117647(ZN)0.882353
COZN_GAMMA1	Co2Zn15		mS28	(12, C2/m)		2	(CO)0.125(ZN)0.875
COZN_GAMMA2	CoZn13		mS28	(12, C2/m)		2	(CO)0.0714286(ZN)0.9285714
CU9GA4_0	gamma-brass (Cu9Al4, D83)	D83	cP52	(215, P-43m)		3	(CU)6.0(CU, GA)6.0(GA)1.0
CU9GA4_1	gamma-brass (Cu9Al4, D83)	D83	cP52	(215, P-43m)		4	(CU)6.0(CU, GA)3.0(CU, GA)3.0(GA)1.0
CU9GA4_2	Cu8.2Ga4.8		cP52			4	(CU)3.0(CU, VA)3.0(CU, GA)3.0(GA)4.0
CU9GA4_3	Cu7.15Ga5.85		cP52			3	(CU, VA)6.0(CU, GA)3.0(GA)4.0
CUGA2	FeSi2-h		tP3	(123, P4/mmm)		2	(CU)1.0(GA)2.0

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
CUGA_THETA	Unknown Structure					2	(CU)0.778(GA)0.222
CU3GE_ETA	beta-TiCu3 (D0a)	D0a	oP8	(59, Pmmn)		2	(CU)0.75(GE)0.25
CU3GE_EPSILON	Na3As (D018)	D018	hP8	(194, P6_ 3/mmc)		2	(CU)0.765(GE)0.235
CU3GE_THETA	BiF3 (D03)	D03	cF16	(225, Fm-3m)		2	(CU)0.735(GE)0.265
CU8HF3	Cu8Hf3		oP44	(62, Pnma)		2	(CU)8.0(HF, ZR)3.0
CU1HF2	CuZr2		tI6	(139, I4/mmm)		2	(AG, CU)1.0(HF)2.0
CU3IN_GAMMA	gamma-brass (Cu9Al4, D83)	D83	cP52	(215, P-43m)		3	(AG, CU)0.654(AG, CU, IN)0.115(IN, SN)0.231
CU2IN_LT	Unknown Structure					2	(CU)0.64(IN)0.36
CU7IN3_DELTA	Cu7In3		aP40	(2, P-1)		2	(CU)0.7(IN, SN)0.3
CUPD	CsCl (B2)	B2	cP2	(221, Pm-3m)		3	(CU, PD)0.5(CU, PD)0.5(VA)1.0
CU17SB3_HT	Hexagonal Close Packed (Mg, A3, hcp)	A3	hP2	(194, P6_ 3/mmc)		2	(CU)0.85(SB)0.15
CU10SB3_HT	Cu10Sb3		hP26	(176, P6_3/m)		2	(CU)0.77(SB)0.23
CU2SB	Cu2Sb (C38)	C38	tP6	(129, P4/nmm)		2	(CU)0.67(SB)0.33
CU11SB3	Cu11Sb3		oS28	(38, Amm2)		2	(CU)0.8(SB)0.2
CU33SI7_A13	beta-Mn (A13)	A13	cP20	(213, P4_132)		2	(CO, CU, ZN)0.835821(SI, ZN)0.164179
CU15SI4_EPSILON	Cu15Si4 (D86)	D86	cI76	(220, I-43d)		2	(CU, ZN)0.789474(SI)0.210526
CU9SI2_DELTA	Unknown Structure					2	(CU, ZN)0.825(SI)0.175

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
CU19SI6_ETA	Unknown Structure					2	(CU, ZN)0.76(SI)0.24
CU3SN	Cu3Sn		oS80	(63, Cmcm)		2	(AU, CU, PD)0.75(CU, IN, SB, SN)0.25
CU41SN11	Cu41Sn11		cF416	(216, F-43m)		2	(CU)0.788(IN, SN)0.212
CU10SN3	Cu10Sn3		hP26	(173, P6_3)		2	(CU, NI)0.769(SN)0.231
CU6SN5_LT	Cu6Sn5		mS44	(15, C2/c)		2	(CU)0.545(SN)0.455
CU4TI_OP20	Au4Zr		oP20	(62, Pnma)		2	(AG, CU, TI)4.0(CU, TI)1.0
CU2TI	Au2V		oS12	(63, Cmcm)		2	(CU)2.0(TI)1.0
CU3TI2	Cu3Ti2		tP10	(129, P4/nmm)		2	(AG, CU)3.0(TI)2.0
CU4TI3	Cu4Ti3		tI14	(139, I4/mmm)		2	(AG, CU)4.0(TI)3.0
CUTI_B11	gamma-CuTi (B11)	B11	tP4	(129, P4/nmm)		2	(AG, CU, TI, ZR)1.0(AG, CU, TI, ZR)1.0
CU5ZR_C15B	AuBe5 (C15b)	C15b	cF24	(216, F-43m)		3	(AG, CU)1.0(AG, CU)4.0(HF, ZR)1.0
CU51ZR14	Ag51Gd14		hP68	(175, P6/m)		2	(CU)51.0(HF, ZR)14.0
CU10ZR7	Ni10Zr7		oS68	(64, Cmce)		2	(AG, CU)10.0(HF, ZR)7.0
CUZR_B2	CsCl (B2)	B2	cP2	(221, Pm-3m)		2	(AG, CU)1.0(ZR)1.0
GAHF_OP24	ThIn		oP24	(57, Pbcm)		2	(GA)1.0(HF)1.0
GA10HF11	Ge10Ho11		tI84	(139, I4/mmm)		2	(GA)10.0(HF)11.0
ZINCBLENDE_B3	Zincblende (ZnS, B3)	B3	cF8	(216, F-43m)		2	(GA)0.5(SB)0.5

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
GA6PT	Unknown Structure					2	(GA, GE)0.857(PT)0.143
GA7PT3	Ir3Ge7 (D8f)	D8f	cI40	(229, Im-3m)		2	(GA, GE)0.7(PT)0.3
GAPT	FeSi (B20)	B20	cP8	(198, P2_13)		2	(GA, GE)0.5(PT)0.5
GA3PT5	Ga3Pt5		oS16	(65, Cmmm)		2	(GA, GE)0.375(PT)0.625
GAPT2	GaPt2		oP24	(51, Pmma)		2	(GA, GE)0.333(PT)0.667
GAPT3	Bogdanovite (Cu3Au, L12)	L12	cP4	(221, Pm-3m)		2	(GA, GE, PT)0.25(GA, PT)0.75
FCC_L10	CuAu (L10)	L10	tP2	(123, P4/mmm)		2	(GA, TI)0.5(GA, TI)0.5
GATI2_B82	Ni2In (B82)	B82	hP6	(194, P6_3/mmc)		2	(GA)1.0(TI)2.0
GA3TI5_D8M	W5Si3 (D8m)	D8m	tI32	(140, I4/mcm)		2	(GA)3.0(TI)5.0
GA4TI5	Ti5Ga4		hP18	(193, P6_3/mcm)		2	(GA, TI)4.0(GA, TI)5.0
GA3TI2	Ti2Ge3		tP10	(83, P4/m)		2	(GA)3.0(TI)2.0
GA2TI	Ga2Hf		tI24	(141, I4_1/amd)		2	(GA)2.0(HF, TI)1.0
BCT_D022	Al3Ti (D022)	D022	tI8	(139, I4/mmm)		2	(GA)3.0(HF, TI)1.0
GA3ZR_D023	Al3Zr (D023)	D023	tI16	(139, I4/mmm)		2	(GA)3.0(ZR)1.0
GA2ZR	Ga2Zr		oS12	(65, Cmmm)		2	(GA)2.0(ZR)1.0
GA5ZR3	Pd5Pu3		oS32	(63, Cmcm)		2	(GA)5.0(ZR)3.0

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
GA3ZR2	Zr2Al3		oF40	(43, Fdd2)		2	(GA)3.0(HF, ZR)2.0
GAZR_BG	MoB (Bg)	Bg	tI16	(141, I4_ 1/amd)		2	(GA)1.0(ZR)1.0
GAZR_BETA	Unknown Structure					2	(GA)1.0(ZR)1.0
GA4ZR5	Ti5Ga4		hP18	(193, P6_ 3/mcm)		2	(GA)4.0(ZR)5.0
GA2ZR3_D5A	Si2U3 (D5a)	D5a	tP10	(127, P4/mbm)		2	(GA)2.0(ZR)3.0
GA3ZR5_D88	Mavlyanovite (Mn5Si3, D88)	D88	hP16	(193, P6_ 3/mcm)		2	(GA)3.0(ZR)5.0
GAZR2_C16	Khatyrkite (Al2Cu, C16)	C16	tI12	(140, I4/mcm)		2	(GA)1.0(ZR)2.0
GENI3_HT	Bogdanovite (Cu3Au, L12)	L12	cP4	(221, Pm-3m)		2	(NI)0.744(GE)0.256
GE2NI5_HT	Pd5Sb2		hP42	(185, P6_3cm)		2	(NI)0.72(GE)0.28
GENI2	Co2Si (C37)	C37	oP12	(62, Pnma)		2	(NI)0.665(GE)0.335
GE3NI5_C2	Ge3Ni5		mS32	(5, C2)	Ge3Ni5, Pb3Pd5	2	(NI, PD)0.625(GE, PB)0.375
GEPT3_MS16	GePt3		mS16	(12, C2/m)	GePt3, Ni25Si9, Pt3Si_ LT	2	(GA, GE, PT, SI)0.25(NI, PT)0.75
GE2PT	Hydrophilite (CaCl2, C35)	C35	oP6	(58, Pnnm)		2	(GA, GE)0.66667(PT)0.33333
GE3PT2	Pt2Ge3		oP20	(62, Pnma)		2	(GA, GE)0.6(PT)0.4
GE2PT3	Pt3Ge2		oP40	(62, Pnma)		2	(GA, GE)0.4(PT)0.6
GEPT2	Revised Fe2P (C22)	C22(II)	hP9	(189, P-62m)		2	(GA, GE)0.333(PT)0.667

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
HF5SN3_D88	Mavlyanovite (Mn5Si3, D88)	D88	hP16	(193, P6_3/mcm)		2	(HF)5.0(GA, SN)3.0
HF5SN4	Ti5Ga4		hP18	(193, P6_3/mcm)		2	(HF)5.0(SN)4.0
HFSN2_C40	CrSi2 (C40)	C40	hP9	(180, P6_222)		2	(HF)1.0(SN)2.0
IN9NI13	Ga9Ni13		mS44	(12, C2/m)		3	(NI, VA)1.0(IN, SN)1.0(NI)1.0
INNI_DELTA	CoSn (B35)	B35	hP6	(191, P6/mmm)		2	(NI, VA)1.0(IN, NI)1.0
NI3SN_D019	Ni3Sn (D019)	D019	hP8	(194, P6_3/mmc)	InNi3, Mn3Sn, Ni3Sn_LT	2	(AU, CO, CU, GA, MN, NI, SN, TI)0.75(GA, IN, NI, SI, SN, TI)0.25
B2_INPD	CsCl (B2)	B2	cP2	(221, Pm-3m)		2	(AG, IN, PD)0.5(PD, VA)0.5
IN7PD3	Ir3Ge7 (D8f)	D8f	cI40	(229, Im-3m)		2	(IN)0.71(PD)0.29
INPD2_BETA	Co2Si (C37)	C37	oP12	(62, Pnma)		2	(IN)0.34(PD)0.66
INPD3_ALPHA	CuAu (L10)	L10	tP2	(123, P4/mmm)		2	(IN)0.25(AG, PD)0.75
INPD3_BETA	Al3Zr (D023)	D023	tI16	(139, I4/mmm)		2	(IN)0.26(PD)0.74
IN7PT3	Ir3Ge7 (D8f)	D8f	cI40	(229, Im-3m)		2	(IN)7.0(PT)3.0
INPT	AlCu(r)		mS20	(12, C2/m)		2	(IN, PT)1.0(IN, PT)1.0
IN5PT6	Face-Centered Cubic (Cu, A1, fcc)	A1	cF4	(225, Fm-3m)		2	(IN, PT)5.0(IN, PT)6.0
IN9PT13	Ga9Ni13		mS44	(12, C2/m)		2	(IN)9.0(IN, PT)13.0
IN2PT3_ALPHA	Pt3Tl2		hP20	(194, P6_3/mmc)		2	(IN)2.0(PT)3.0

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
IN2PT3_BETA	Ni2In (B82)	B82	hP6	(194, P6_ 3/mmc)		2	(IN, PT)2.0(IN, PT)3.0
INPT2	Ga3Pt5		oS16	(65, Cmmm)		2	(IN)1.0(PT)2.0
INSN_GAMMA	(Hg0.1Sn0.9)		hP1	(191, P6/mmm)		1	(BI, IN, PB, SB, SN)1.0
IN5TI2	Hg5Mn2		tP14	(127, P4/mbm)		2	(TI)2.0(IN)5.0
TI8IN5_GAMMA_D83	gamma-brass (Cu9Al4, D83)	D83	cP52	(215, P-43m)		2	(TI)8.0(IN)5.0
IN3ZR_D023	Al3Zr (D023)	D023	tI16	(139, I4/mmm)		2	(IN)0.75(ZR)0.25
ZRIN2	Ga2Hf		tI24	(141, I4_ 1/amd)		2	(ZR)1.0(IN)2.0
ZR1IN1	Unknown Structure					2	(ZR)1.0(IN)1.0
ZR3IN_L12	Bogdanovite (Cu3Au, L12)	L12	cP4	(221, Pm-3m)		2	(ZR)3.0(IN)1.0
MG5GA2	Ga2Mg5 (D8g)	D8g	oI28	(72, Ibam)		2	(MG)0.7143(GA)0.2857
MG2GA	Li2Sb		hP18	(190, P-62c)		2	(MG)0.6667(GA)0.3333
MGGA	MgGa		tI32	(88, I4_1/a)		2	(MG)0.5(GA)0.5
MGGA2	MgGa2		oP24	(55, Pbam)		2	(MG)0.3333(GA)0.6667
MG2GA5	Ga5Mg2		tI28	(139, I4/mmm)		2	(MG)0.2857(GA)0.7143
MG7ZN3	Mg51Zn20		oI158	(71, Immm)		2	(MG)51.0(ZN)20.0

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
MGZN	Zr21Re25		hR92	(167, R-3c)		2	(MG)12.0(AL, CU, ZN)13.0
MG2ZN3	Mg4Zn7		mS110	(12, C2/m)		2	(MG)2.0(AL, CU, ZN)3.0
MG2ZN11	Mg2Zn11 (D8c)	D8c	cP39	(200, Pm-3)		3	(AL, ZN)5.0(ZN)6.0(MG)2.0
C14_LAVES	MgZn2 Hexagonal Laves (C14)	C14	hP12	(194, P6_ 3/mmc)	MgZn2	2	(AL, MG, ZN)2.0(AL, MG, ZN)1.0
MN3SN2	Tongbaite (Cr3C2, D510)	D510	oP20	(62, Pnma)		2	(MN)3.0(SN)2.0
NI3SB_HT	BiF3 (D03)	D03	cF16	(225, Fm-3m)		3	(SB)0.25(CO, NI, VA)0.5(NI, VA)0.25
NI5SB2_THETA	Ni5Sb2		mS28	(5, C2)		2	(CO, NI)0.7143(NI, SB)0.2857
NI3SI_HT	Cementite (Fe3C, D011)	D011	oP16	(62, Pnma)		2	(NI)3.0(SI)1.0
NI3SI2	Ni3Si2		oP80	(36, Cmc2_1)		2	(NI)3.0(SI)2.0
NI5SI2	Ni31S12		hP42	(150, P321)		2	(NI)5.0(SI)2.0
NI3SN4	delta-Ni3Sn4 (D7a)	D7a	mS14	(12, C2/m)		3	(CU, NI)0.25(IN, NI, SN)0.25(IN, SN)0.5
NIZN_TP2	CuAu (L10)	L10	tP2	(123, P4/mmm)	NiZn, PdZn	2	(CU, NI, PD, ZN)0.5(NI, PD, ZN)0.5
NIZN8_DELTA	Ni3Zn22		mS50	(12, C2/m)		2	(NI)1.0(ZN)8.0
PBPD3	Bogdanovite (Cu3Au, L12)	L12	cP4	(221, Pm-3m)		2	(PD)0.75(PB, PD)0.25
PB3PD5_BETA	Unknown Structure					3	(PD)1.0(PB)1.0(PD, VA)1.0
PB9PD13	Pb9Pd13-alpha		mS88	(15, C2/c)		2	(PD)0.59(PB)0.41
PBPD	PdPb		aP32	(2, P-1)		2	(PD)1.0(PB)1.0
PBPT3	Bogdanovite (Cu3Au,	L12	cP4	(221, Pm-3m)		2	(AL, NI, PB, PT, SI)0.25(AL, NI, PT)0.75

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
	L12)						
PB4PT	PtPb4 (D1d)	D1d	tP10	(125, P4/nbm)		2	(PB)0.8(PT)0.2
PD3SB	NaTl (B32)	B32	cF16	(227, Fd-3m)		2	(PD, SB)3.0(SB)1.0
PD20SB7	Pd20Sb7		hR27	(148, R-3)		2	(PD)20.0(SB)7.0
PD8SB3	Yb8In3		hR132	(167, R-3c)		2	(PD)8.0(SB)3.0
PD5SB2	Pd5Sb2		hP42	(185, P6_3cm)		2	(PD)5.0(SB)2.0
PD2SB	Pd2As		oS24	(36, Cmc2_1)		2	(PD)2.0(SB)1.0
PD5SB3	Unknown Structure					2	(PD, SB)5.0(PD, SB)3.0
PD21SI4	Unknown Structure					2	(PD, SI)21.0(SI)4.0
PD5SI	Pd5Si		mP24	(4, P2_1)		2	(PD)5.0(SI)1.0
PD14SI3	Unknown Structure					2	(PD)14.0(SI)3.0
PD9SI2	Pd9Si2		oP44	(62, Pnma)		2	(PD)9.0(SI)2.0
PD15SI4	Unknown Structure					2	(PD)15.0(SI)4.0
PD2SI_ALPHA	Unknown Structure					2	(PD, SI)2.0(SI)1.0
PD2SI_BETA	Revised Fe2P (C22)	C22(II)	hP9	(189, P-62m)		2	(PD, SI)2.0(SI)1.0
PD39SI20	Unknown Structure					2	(PD)39.0(SI)20.0
PD19SI10	Unknown Structure					2	(PD)19.0(SI)10.0
PD3SN	Bogdanovite (Cu3Au, L12)	L12	cP4	(221, Pm-3m)		2	(PD, SN)0.75(PD, SN)0.25

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
PD20SN13	Ga3Ge6Ni13		hP66	(152, P3_121)		2	(PD, SN)0.6(PD, SN)0.4
PDSN2	PdSn2		tI48	(142, I4_ 1/acd)		2	(PD, SN)0.333(SN)0.667
PD3SN2_ALPHA	Unknown Structure					2	(PD)0.6(SN)0.4
PD3SN2_BETA	Unknown Structure					2	(PD)3.0(SN)2.0
PD3SN2_GAMMA	Unknown Structure					2	(PD)0.59(SN)0.41
PDZN_GAMMA	gamma-brass (Cu5Zn8, D82)	D82	cI52	(217, I-43m)		2	(PD, ZN)2.0(PD, ZN)9.0
PDZN_BETA	CsCl (B2)	B2	cP2	(221, Pm-3m)		2	(PD, ZN)1.0(PD, ZN)1.0
PDZN2	Zn5(Zn0.33Pd0.67)Pd2		oS48	(65, Cmmm)		2	(PD)1.0(ZN)2.0
PDZN_ETA	Unknown Structure					2	(PD)0.09(ZN)0.91
PT7SB	Ca7Ge		cF32	(225, Fm-3m)		2	(PT)0.865(SB)0.125
PT3SB	Al3Zr (D023)	D023	tI16	(139, I4/mmm)		2	(PT)0.75(SB)0.25
PT3SB2	Pt3Sb2		oI20	(72, Ibam)		2	(PT)0.6(SB)0.4
PTSB	NiAs (B81)	B81	hP4	(194, P6_ 3/mmc)		2	(PT)0.5(SB)0.5
PTSB2	Pyrite (FeS2, C2)	C2	cP12	(205, Pa-3)		2	(PT)0.333(SB)0.667
PT5SB	Bogdanovite (Cu3Au, L12)	L12	cP4	(221, Pm-3m)		2	(PT, SB)0.833(PT, SB)0.167
PT2SI_LT_ALPHA	ThH2 (L'2b)	L'2b	tI6	(139, I4/mmm)		2	(PT)0.66667(SI)0.33333
PT2SI_HT_BETA	Revised Fe2P (C22)	C22(II)	hP9	(189, P-62m)		2	(PT)0.66667(SI)0.33333

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
PT6SI5	Pt6Si5		mP22	(11, P2_1/m)		2	(PT)0.545(SI)0.455
PT5SI2	Unknown Structure					2	(PT)0.714(SI)0.286
PT17SI8_BETA	Ni12P5		tI34	(87, I4/m)		2	(PT)0.68(SI)0.32
PT17SI8_ALPHA	Pt12Si5		tP68	(85, P4/n)		2	(PT)0.68(SI)0.32
PT25SI7	Unknown Structure					2	(PT)0.782(SI)0.218
PT2SN3	Pt2Sn3 (D5b)	D5b	hP10	(194, P6_ 3/mmc)		2	(PT)0.4(SN)0.6
PT3SN	Bogdanovite (Cu3Au, L12)	L12	cP4	(221, Pm-3m)		2	(PT)0.75(SN)0.25
SBSN_B1_NACL	Rock Salt (NaCl, B1)	B1	cF8	(225, Fm-3m)		2	(BI, GE, IN, SB, SN)0.5(BI, GE, IN, PB, SB, SN)0.5
SB2SN3	Unknown Structure					2	(SB)0.4(AG, SN)0.6
SB9ZN11_GAMMA	Unknown Structure					2	(SB)0.45(ZN)0.55
SB19ZN31_ETA	Sb2Zn3-ht1		oP30	(59, Pmmn)		2	(SB)0.38(ZN)0.62
SB4ZN6_ZETA	Sb2Zn3-ht2		oP192	(56, Pccn)		2	(SB)0.4(ZN)0.6
SB17ZN23_LT	Unknown Structure					2	(SB)0.425(CD, ZN)0.575
SB17ZN23_HT	Unknown Structure					2	(SB)0.425(ZN)0.575
SBZN	CdSb (Be)	Be	oP16	(61, Pbca)		2	(SB)0.5(CD, ZN)0.5
SN3TI2	Ti2Sn3		oS40	(64, Cmce)		2	(SN)3.0(TI)2.0
SN5TI6	Sn5Ti6-beta		hP22	(194, P6_ 3/mmc)		2	(SN)5.0(CU, TI)6.0
SN3TI5_D88	Mavlyanovite (Mn5Si3,	D88	hP16	(193, P6_		3	(CU, VA)1.0(SN)3.0(TI)5.0

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
	D88)			3/mcm)			
SNTI2_B82	Ni2In (B82)	B82	hP6	(194, P6_ 3/mmc)		3	(SN, TI)1.0(TI)1.0(TI, VA)1.0
SN2ZR_C54	TiSi2 (C54)	C54	oF24	(70, Fddd)		2	(SN)2.0(ZR)1.0
SN3ZR5_D88	Mavlyanovite (Mn5Si3, D88)	D88	hP16	(193, P6_ 3/mcm)		3	(ZR)5.0(SN)3.0(SN, VA)1.0
SNZR4_A15	Cr3Si (A15)	A15	cP8	(223, Pm-3n)		2	(SN, ZR)1.0(SN, ZR)3.0
AGINPD	Unknown Structure				Ag-In-Pd ternary phase, AgInPd	3	(AG)0.156(IN)0.26(PD)0.584
AL3CU5ZN2	Cu3.2 (Zn0.18Al0.82)4Al0.9		hR27	(166, R-3m)	Al-Cu-Zn ternary phase, Al3Cu5Zn2	4	(AL, CU)1.0(AL)4.0(CU)4.0(ZN)1.0
ALMGZN_PHI	Mg21(Al,Zn)17		oP152	(57, Pbcm)	Al-Mg-Zn ternary phase, PHI	2	(MG)6.0(AL, ZN)5.0
T_PHASE	Bergman [Mg32(Al,Zn)49, D8e]	D8e	cI162	(204, Im-3)	Solution (Al,Zn)49Mg32, stable in Al-Mg-Zn	4	(MG)26.0(AL, MG)6.0(AL, MG, ZN)48.0(AL)1.0
AUBISN	Unknown Structure				Au-Bi-Sn ternary phase, AuBiSn	3	(AU)0.485(SN)0.11(BI, SN)0.405
AUCOSN4	delta-Ni3Sn4 (D7a)	D7a	mS14	(12, C2/m)	Au-Co-Sn ternary phase, AuCoSn4	3	(AU)0.1500015(CO)0.249925(SN)0.60006
AU2CU2SN	La2Sb		tI12	(139, I4/mmm)	Au-Cu-Sn ternary phase, Au2Cu2Sn	3	(AU)0.4(CU)0.4(SN)0.2
AU4IN3SN3	Pt2Sn3 (D5b)	D5b	hP10	(194, P6_ 3/mmc)	Au-In-Sn ternary phase, Au4In3Sn3	3	(AU)0.4(IN, SN)0.3(IN, SN)0.3
AUNI2SN4	AuNi2Sn4		hR7	(166, R-3m)	Au-Ni-Sn ternary phase, AuNi2Sn4	3	(SN)0.571(AU)0.143(NI)0.286

Name	Prototype	Strukturbericht	Pearson Symbol	Space Group	Info	Sublattices	Formula Unit
AUPT2SN4_TAO	Unknown Structure				Au-Pt-Sn ternary phase, AuPt2Sn4	3	(AU)1.0(PT)2.0(SN)4.0
CU77INSN23	Unknown Structure				Cu-In-Sn ternary phase, Cu77InSn23	2	(CU)0.77(IN, SN)0.23
CU2IN3SN	Unknown Structure				Cu-In-Sn ternary phase, Cu2In3Sn	3	(CU)0.333(IN)0.5(SN)0.167
CUNI2SN	Unknown Structure				Cu-Ni-Sn ternary phase, tao 2	3	(CU)0.233(NI)0.5(SN)0.267
CU4MNSN	MgCu4Sn		cF24	(216, F-43m)	Cu-Mn-Sn ternary phase,Cu4MnSn	3	(CU)0.6666(SN)0.1667(MN)0.1667
CUSNTI	BeZrSi		hP6	(194, P6_ 3/mmc)		3	(CU)1.0(SN)1.0(TI)1.0
CU2SNTI	Heusler (L21)	L21	cF16	(225, Fm-3m)		3	(CU)2.0(SN)1.0(TI)1.0
CU2TIZR	MgZn2 Hexagonal Laves (C14)	C14	hP12	(194, P6_ 3/mmc)		3	(CU)2.0(TI)1.0(ZR)1.0
GA11GEPT7	Unknown Structure					3	(GA)0.579(GE)0.053(PT)0.368
GA3GEPT8	Co2Si (C37)	C37	oP12	(62, Pnma)		2	(GA, GE)0.333(PT)0.667
GAGEPT6	Ir3Si		tI16	(140, I4/mcm)		2	(GA, GE)0.25(PT)0.75
INNI6SN5	Ni(Ga0.25Ge0.75)		oP16	(62, Pnma)	In-Ni-Sn ternary phase, InNi6Sn5	2	(NI)1.0(IN, SN)1.0

TCSLD5 Properties Data

Model Descriptions

For more information about the various thermophysical, thermomechanical, and properties models, and when in Thermo-Calc, press F1 to search the online help. The details are found under a *General Reference* section.

You can find information on our website about the properties that can be calculated with Thermo-Calc and the Add-on Modules. Additional resources are added on a regular basis so keep checking back or subscribe to our newsletter.

Examples

Go to the Solder Alloys Databases page on our website where you can access a Validation and Calculation Examples Collection and the Technical Information plus learn more about the compatible kinetic database. Also explore further applications of Thermo-Calc to solders including links to resources such as examples, publications, and more.

TCSLD: TCS Solder Alloy Solutions Database Revision History

Current Database Version

Database name (acronym):	**TCS Solder Alloy Solutions Database (TCSLD)**
Database owner:	**Thermo-Calc Software AB**
Database version:	**5.1**
First release:	**TCSLD1 was released in 2010**

Changes in the Most Recent Database Release

TCSLD5.0 to TCSLD5.1

Software release version 2025a (January 2025)

- Improved phase description of HCP_A3 and EPSILON_HCP in Ag-Sb-Zn, Ag-Sn-Zn, Al-Cu-Zn, and Cu-Si-Zn systems
- Added the Ag-Cu-Zn system

Previous Releases

TCSLD4.2 to TCSLD5.0

Software release version: 2024b (June 2024)

New Elements

- Hf, Ti, and Zr are added making a 24 element framework.

Binary Systems

- 161 assessed binary systems are now included.
- 19 new: Ag-Hf, Ag-Ti, Ag-Zr, Bi-Mg, Bi-Mn, Cu-Hf, Cu-Ti, Cu-Zr, Ga-Hf, Ga-Ti, Ga-Zr, Hf-Sn, Hf-Ti, Hf-Zr, In-Ti, In-Zr, Sn-Ti, Sn-Zr, and Ti-Zr.
- Three (3) reassessed: Mg-Pb, Ni-Pb, and In-Pb.

Ternary Systems

- 77 assessed ternary systems are now included.
- Five (5) new: Ag-Cu-Ga, Ag-Cu-Ti, Ag-Cu-Zr, Cu-Sn-Ti, and Cu-Ti-Zr.
- One (1) reassessed: Bi-Sb-Sn.

Phases

- 56 new and updated phases for a total of 328.
- The HCP_A3 phase is restored as the lattice stability of Zn, and the interaction parameters are adjusted accordingly.

TCSLD4.1 to TSCLD4.2

Software release version: 2022b (June 2022)

- Bi-Sn is re-assessed.
- Au-Co is updated.

TCSLD4.0 to TCSLD4.1

Software release version: 2022a (December 2021/January 2022)

- Sn-Bi binary system is updated.
- More viscosity and surface tension parameters were added. All thermodynamically assessed systems now have VISC/SURF parameters.
- Viscosity of Ag-Au is re-assessed and added for Ag-Au-Cu.
- The description of the molar volume of BCT_A5 Sn is corrected.

TCSLD3.3 to TCSLD4

Software release version: 2021b (June 2021)

Addition of surface tension and viscosity thermophysical property data.

TCSLD3.2 to TCSLD3.3

Software release version: 2020b (June 2020)

- Added 3 binary systems Ga-Bi, Ga-Sb, Ga-In

TCSLD3.1.1 TO TCSLD3.2

Software release version: 2017a (March 2017)

- Ca is added together with some Ca-related systems: Al-Ca, Ca-Sn, Ca-Pb, Ca-Pb-Sn
- Added the Mg-Sn and Mg-Pb binary systems.
- Added the Bi-Cu-Sb ternary system.
- Updated the Ag-Au-Cu system.

TCSLD3.1 TO TCSLD3.1.1

Released with the 2015b update in March 2016.

- Thermodynamic assessments of the Ga-Ge and Ga-Pt binary systems are added.
- Thermodynamic descriptions of the Ag-Cu-Pd and Ga-Ge-Pt ternary systems are included.

TCSLD3.0 TO TCSLD3.1

Software release version: 2015b (December 2015)

- Volume data for the liquid phase are updated for some Ag/Bi/Cu/In-containing binary systems and a few Ag-containing ternary systems.
- Thermodynamic description of the Au-Pb-Sn ternary system is added.

TCSLD2 TO TCSLD3.0

Software release version: 2015a (June 2015)

- Volume data, including molar volume and thermal expansion, have been added in TCSLD3. This allows for the calculations of volume fraction of phases, density, thermal expansion and lattice parameters etc.
- Four elements, Cd, Ga, Mg, Mn, have been added in TCSLD3. The thermodynamic assessments of the Ag-Ga, Al-Ga, Al-Mg, Cd-Cu, Cd-Pb, Cd-Sb, Cd-Sn, Cd-Zn, Cu-Ga, Cu-Mn, Ga-Mg, Ga-Sn, Ga-Zn, Mn-Sn, Mg-Zn binary systems have been implemented. The following ternary systems have also been assessed: Al-Ga-Zn, Al-Mg-Zn, Cd-Pb-Sn, Cd-Sb-Zn, Cu-Mn-Sn, Ga-Sn-Zn.

TCSLD1 TO TCSLD2

Software release version: 4.0 (June 2014)

The thermodynamic assessments of the Ge-Pt and Pt-Sb binary systems have been included in TCSLD2. The descriptions of Ag-Ge, Ag-Pd, Al-Au, Al-Bi, Al-Co, Al-Si, Au-Bi, Au-Co, Au-Ge, Au-Sb, Bi-Cu, Bi-Ni, Bi-Sn, Co-Ge, Co-Zn, Cu-Ge, Cu-Pb, Cu-Zn, Ge-Ni, Ge-Sb, In-Pb, Ni-Sn, Ni-Zn, Pb-Pt, Pb-Sb, Pb-Zn have been updated, taking into account newly available experimental data and/or the compatibility in higher order systems. In most cases, especially when it is important, the phases having the same crystal structure have been merged as the same phase.

The following ternary systems have been implemented in TCSLD2: Ag-Au-Ge, Ag-In-Pd, Al-Cu-Sn, Al-Ge-Zn, Al-Sn-Zn, Au-Cu-Sb, Au-Ge-Sn, Co-Ni-Sb, Cu-Ni-Sn, Ge-Sb-Sn, In-Pb-Sn, Pb-Sb-Sn, Pb-Sn-Zn. The descriptions of Ag-Au-Pb, Ag-Au-Sn, Ag-Bi-Sn, Ag-Cu-In, Ag-Sb-Sn, Ag-Sb-Zn, Ag-Sn-Zn, Al-Bi-Sn, Al-Bi-Zn, Al-Cu-Zn, Au-Bi-Sn, Au-In-Sb, Au-In-Sn, Au-Ni-Sn, Au-Sb-Sn, Bi-In-Sn, Bi-Sb-Sn, Cu-In-Sn, Cu-Si-Zn, In-Ni-Sn, In-Sb-Sn have been updated on a basis of critical evaluation of available experimental and theoretical data. Please note that minor revisions have also been made on many other binary and ternary systems.