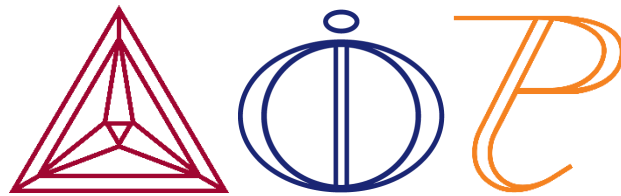




Release Notes:

Thermo-Calc Software Package

Version 2020b



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## Thermo-Calc Highlights in 2020b

- ★ **Thermo-Calc Thermophysical Properties:** Viscosity, surface tension, thermal conductivity, electric resistivity and/or molar volume are added to the three new databases (i.e. TCAL7, TCNI10 and TCOX10) as indicated and available in Thermo-Calc as variables, parameters and more via Graphical Mode, Console Mode, and the SDKs such as TC-Python. See [Thermophysical Property Data: Viscosity, Surface Tension and More](#) and the database section.
  
- ★ **Thermo-Calc Property Models:** Improvement to the Yield Strength Model makes it even more accurate and the Model is now available with the Precipitation Module (TC-PRISMA). See [Yield Strength Property Model](#).
  
- ★ **Precipitation Module (TC-PRISMA):** The improved Yield Strength Property Model is now available as a plot quantity with the Plot Renderer and Table Renderer when using the Precipitation Calculator. See [Yield Strength Property Model Available with the Precipitation Calculator](#).
  
- ★ **Thermo-Calc Process Metallurgy Module and TCOX10 Database:** A new EERZ model enables the simulation of kinetics during the steelmaking process, plus three new examples. See [Process Simulations using EERZ Model](#). In addition, the [TCOX10 TCS Metal Oxide Solutions Database](#) has a new version, which is integral to the use of this new kinetic model.
  
- ★ **Databases:** New thermophysical properties are included as indicated for three new thermodynamic databases—Al-based alloys (TCAL7), Ni-based superalloys (TCNI10) and metal oxide solutions (TCOX10). Plus six updated thermodynamic databases are available. See [New Thermodynamic Databases](#) and [Updated Thermodynamic Databases](#).
  
- ★ **TC-Python:** Support for adding composition sets and species and extended and improved functionality for the GES system for unencrypted databases. See [TC-Python API](#).

## Thermophysical Properties: Viscosity, Surface Tension, Thermal Conductivity and Electric Resistivity

*These thermophysical properties are included with the new databases as indicated and available in Thermo-Calc as variables, parameters and more via Graphical Mode, Console Mode, and the SDKs such as TC-Python.*

Since the 2020a release, some of our thermodynamic databases contain not only the Gibbs energy and volume data, but also many other thermophysical property data, e.g. viscosity, surface tension, thermal conductivity and electric resistivity. This new property data is essential for simulating the mass and heat transfer in material manufacturing processes, e.g. casting and 3D printing, but it is usually not available in a composition specific form.

By extending our thermodynamic databases to include properties data, users are able to easily calculate viscosity, surface tension and thermal conductivity in variation with multicomponent compositions when phase diagrams, liquidus, solidus, solvus, density, volume, coefficient of thermal expansion, heat capacity and latent heat are obtained at the same time.

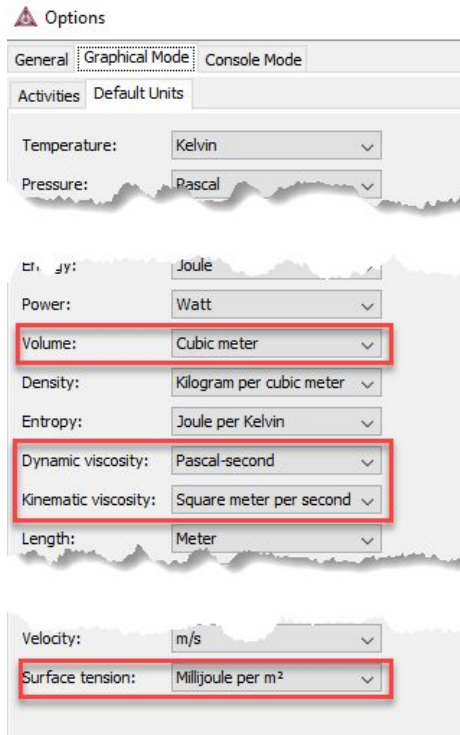
This release includes additions to only three databases, but in the future, thermophysical properties will be added to more databases, so keep an eye on your databases to see when they receive new thermophysical properties.



Read more in these release notes for the new [TCAL7 TCS Al-based Alloy Database](#), [TCOX10 TCS Metal Oxide Solutions Database](#) and [TCNI10 TCS Ni-based Superalloys Database](#), which have thermophysical properties added. Note that TCFE10 (TCS Steel and Fe-alloys Database) and TCHEA4 (TCS High Entropy Alloys Database) both had viscosity added in the last release (2020a).

## Default Units for Thermophysical Properties

Some of the new thermophysical properties also can have the default units changed. To open the **Options** window, from the main menu select **Tools** → **Options** and click the **Default Units** tab.



## New Examples in Thermo-Calc and with the Databases

Two basic examples of the thermophysical properties viscosity and surface tension are available in both Graphical Mode and Console Mode as example project and macro files, respectively. Both examples use demonstration databases, which are available to all users.

To open the new example files, start in the Mode you want to open and then in Thermo-Calc, from the menu: **Help > Example Files > Thermo-Calc** and then select the file as per the name below.

### Viscosity of Liquid

These examples use the FEDEMO database, which is the free demonstration version of the TCS Steel and Fe-alloys Database (TCFE).

- Graphical Mode: **T\_12\_Viscosity\_in\_Cr-Ni.tcu**
- In Console Mode go to the folder and file of the same name: **tcex55**

### Surface Tension of Liquid

These examples use the ALDEMO database, which is the free demonstration version of the TCS Al-based Alloy Database (TCAL).

- Graphical Mode: **T\_11\_Surface\_tension\_in\_Cu-Zr.tcu**
- In Console Mode go to the folder and file of the same name: **tcex56**

## Thermal Conductivity and Electric Resistivity

Note that for the thermal conductivity and electric resistivity properties added to the [TCAL7 TCS AI-based Alloy Database](#) there are Calculation and Validation plot examples in the Help and in a new Examples Collection PDF.

## Molar Volume in TCOX10

Molar volume is added to this database. The details about the parameters that have been assessed or estimated are included in the *TCOX10 Technical Information* PDF and the Help.



In Thermo-Calc, press F1 to search the Help for *thermophysical properties* to access a variety of information about the models and where these are available with specific databases. Also search for “about the database examples” to see how these are categorized in the new *Examples Collections* on the website and in the Help. See [New Database Technical Information and Examples Collections PDFs](#).

## Property Model Library

*The Property Model Library contains sets of Property Models that are packaged together. Property Models are models that are stored within the software that make it easy to set up calculations in the Property Model Calculator. It is available in Graphical Mode only.*

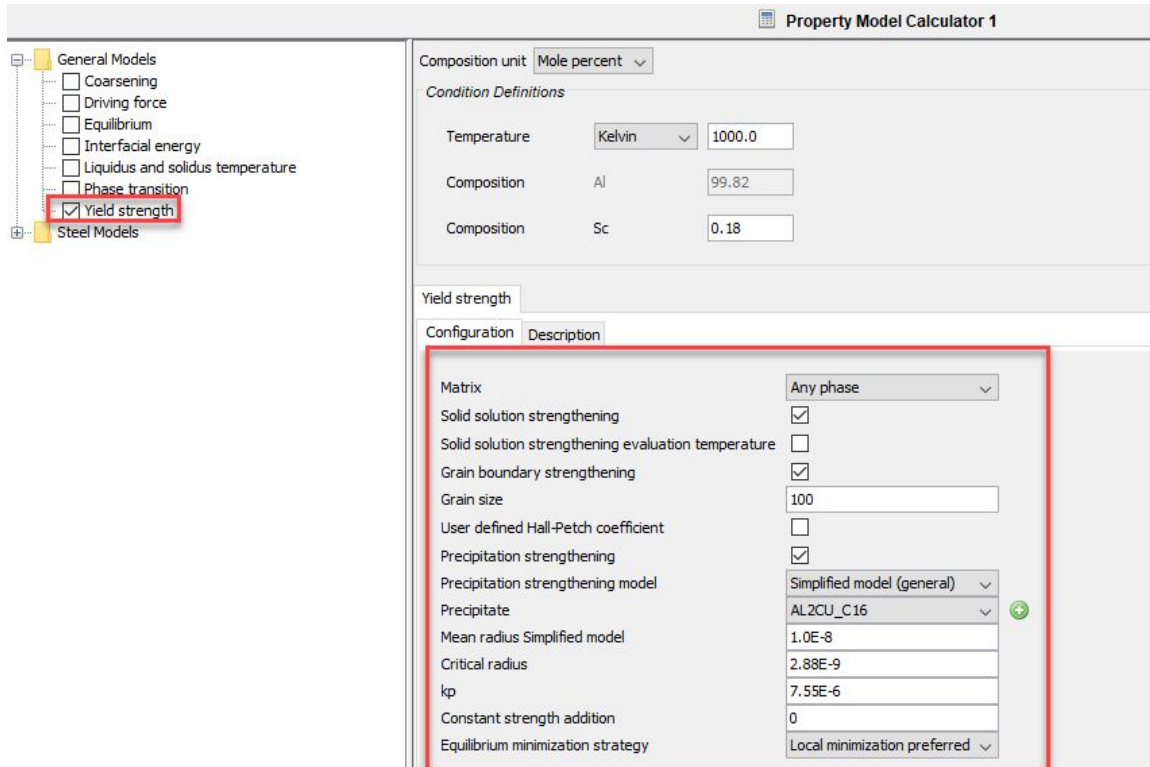
## Yield Strength Property Model

*The Yield Strength Property Model was originally released with Thermo-Calc version 2020a.*

The Yield Strength Model in the Property Model Calculator has important accuracy improvements and has additional functionality when used in combination with the [Precipitation Calculator and the Precipitation Module \(TC-PRISMA\)](#).

The key improvements to the Yield Strength Model are:

- Grain boundary strengthening is assessed for all elements and is optimized for pure elements.
- The Hall-Petch parameter,  $k_{hp}$ , which is used to estimate the grain size hardening, is now estimated by a relation to the melting point for the pure element if  $k_{hp}$  is not explicitly determined from experiment.
- Solid solution strengthening re-optimized to be compatible with all other contributions.
- The Model shows a better fit to experimental data and it allows you to set more than one precipitating phase when calculating precipitation strengthening.



Property Model Calculator 1

Composition unit: Mole percent

Condition Definitions

Temperature: Kelvin 1000.0

Composition: Al 99.82

Composition: Sc 0.18

Yield strength

Configuration Description

Matrix	Any phase
Solid solution strengthening	<input checked="" type="checkbox"/>
Solid solution strengthening evaluation temperature	<input type="checkbox"/>
Grain boundary strengthening	<input checked="" type="checkbox"/>
Grain size	100
User defined Hall-Petch coefficient	<input type="checkbox"/>
Precipitation strengthening	<input checked="" type="checkbox"/>
Precipitation strengthening model	Simplified model (general)
Precipitate	AL2CU_C16
Mean radius Simplified model	1.0E-8
Critical radius	2.88E-9
kp	7.55E-6
Constant strength addition	0
Equilibrium minimization strategy	Local minimization preferred

The Property Model Calculator using a Yield Strength Model. The Configuration settings tab includes the available settings for the Yield Strength Model, which are almost the same as what you see on the Plot Renderer for a Precipitation Calculator when “Yield strength” is selected as an axis variable. Any differences are related to how the specific Precipitation Calculator simulation is set up. See below for details about the Precipitation Module set up.



In Thermo-Calc, press F1 to search the Help for *yield strength* or *Yield Strength Property Model* to learn more about using it and the Property Model Calculator.

## Precipitation Module (TC-PRISMA)

### Yield Strength Property Model Available with the Precipitation Calculator

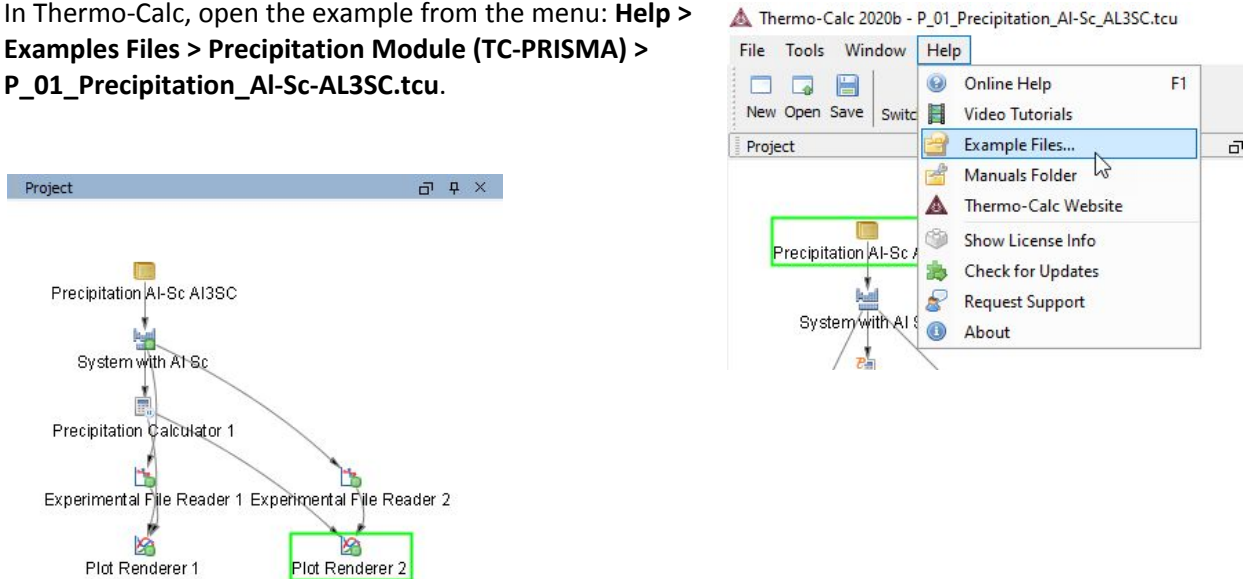
The improved [Yield Strength Property Model](#) is now available as a plot quantity with the Plot Renderer and Table Renderer when using the Precipitation Calculator. Simulation results, such as matrix composition and precipitate amount and sizes, can then be used as input for a Yield Strength Model where results are visualized as a function of time. This is the first mechanical property to be added to the Precipitation Module (TC-PRISMA).



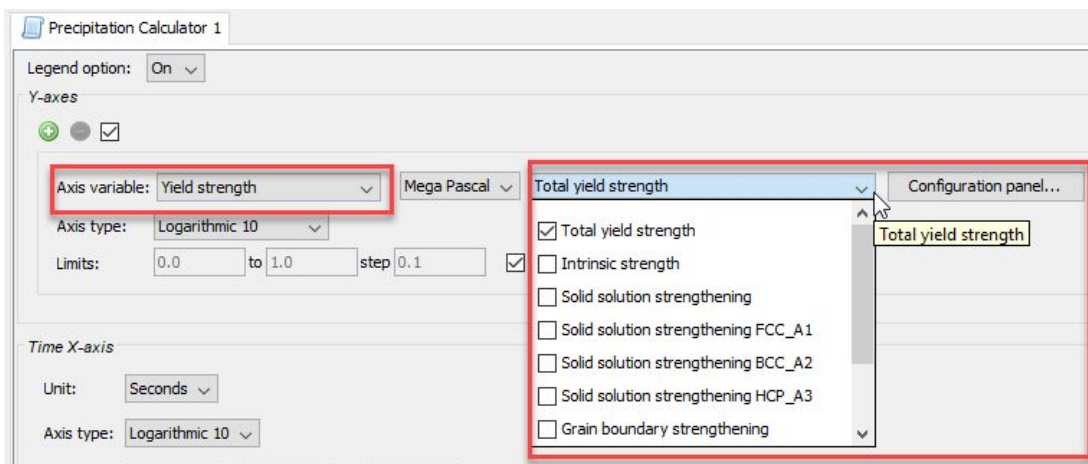
## Updated Example Includes Yield Strength

One of the existing examples is updated to include yield strength. This uses the results from a simulation as input to the Yield Strength Model, i.e. the calculated precipitate radius/radii for each time step is used to calculate the precipitation strengthening, and similarly, the matrix composition for each time step is used to calculate the solid solution strengthening when this is selected in the **Configuration panel** on the Plot Renderer.

In Thermo-Calc, open the example from the menu: **Help > Examples Files > Precipitation Module (TC-PRISMA) > P\_01\_Precipitation\_AI-Sc-AL3SC.tcu**.



After opening the example, click the Plot Renderer 2 node to see the Configuration window where the settings are available.



The Configuration window for the Plot Renderer 2 node as a successor to a Precipitation Calculator. This is from the updated P\_01 example in Thermo-Calc. This example is available to all users, although an Add-on Module license is required to run advanced precipitation simulations and access the full power and functionality of the Module.

Matrix	FCC_A1
Solid solution strengthening	<input checked="" type="checkbox"/>
Solid solution strengthening evaluation temperature	<input type="checkbox"/>
Grain boundary strengthening	<input checked="" type="checkbox"/>
Grain size	100
User defined Hall-Petch coefficient	<input type="checkbox"/>
Precipitation strengthening	<input checked="" type="checkbox"/>
Precipitation strengthening model	Simplified model (general)
Precipitate	AL3SC
Mean radius Simplified model	1.0E-8
Critical radius	2.88E-9
kp	7.55E-6
Constant strength addition	0
Equilibrium minimization strategy	Local minimization preferred

Configuration panel...

The Precipitation Calculator Plot Renderer when “Yield strength” is selected as a plot variable. Click the Configuration panel button on the Plot Renderer to open the available settings for the Yield Strength Model. The greyed out sections (e.g. the Matrix and Precipitate phases) are defined on the Precipitation Calculator and cannot be changed.



In Thermo-Calc, press F1 to search the Help for *yield strength precipitation* to learn more about using it with the Precipitation Module and Precipitation Calculator.

## Process Metallurgy Module

The Process Metallurgy Module is an Add-on Module to Thermo-Calc that makes it easy to set up calculations for steel and slag. It is available in Graphical Mode as the Process Metallurgy Calculator.

## Process Simulations using EERZ Model

A new model, the Effective Equilibrium Reaction Zone (EERZ) is available with the Process Metallurgy Module that enables the simulation of kinetics during the steelmaking process. The addition of this model, along with accompanying changes, makes it possible to simulate the entire steelmaking process from scrap to fully refined steel.

EERZ assumes local equilibrium at the liquid steel slag interface is reached, but that the kinetics of the reaction is limited by the mass and heat transfer along compositional and thermal gradients to and from this reaction interface.



You can read about the EERZ model and its implementation into Thermo-Calc in [two papers available on our website](#). The website also has other learning resources available to help get you

started with the Process Metallurgy Module including videos and in depth details about new examples.

### Three New Process Metallurgy Examples

Three new examples are included with the 2020b release that demonstrate how to set up kinetic simulations. These are detailed in the Help and extensive additional learning resources are available on the website. To open the new examples, in Thermo-Calc, from the menu: **Help > Example Files > Process Metallurgy**

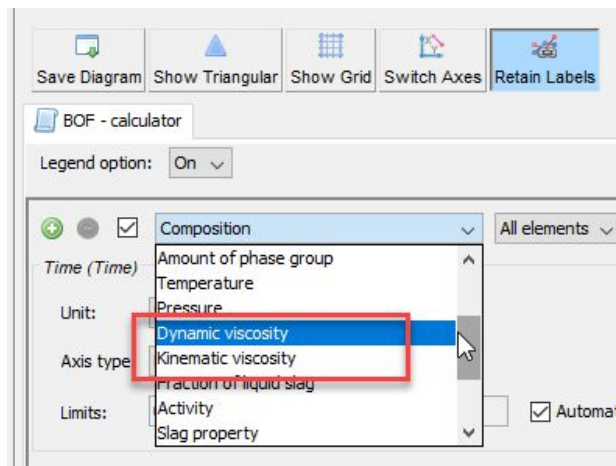
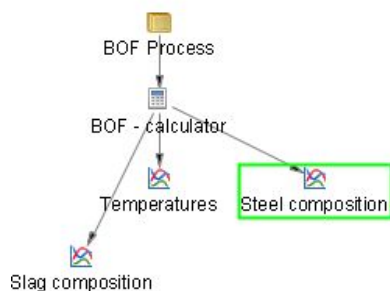
- PMET\_04\_Basic\_Oxygen\_Furnace\_Kinetics.tcu
- PMET\_05\_Lab\_Scale\_Ladle\_Furnace\_Kinetics.tcu
- PMET\_06\_Ladle\_Furnace\_Kinetics.tcu



In Thermo-Calc, press F1 to search the Help for *process metallurgy kinetics* or *Process Metallurgy Calculator* to access a variety of information.

### New Plot Variable: Viscosity of Liquid

Viscosity of liquid (either as **Dynamic viscosity** or **Kinematic viscosity**) is available as a plot variable for the Process Metallurgy Calculator as shown below from the new example **PMET\_04\_Basic\_Oxygen\_Furnace\_Kinetics.tcu**. This is related to the new thermophysical properties available with the TCOX10 database. Also see [TCOX10 TCS Metal Oxide Solutions Database](#) for other changes and search the Help for details about the viscosity model.



### Suspending Components in Console Mode

The POLY module used in Console Mode and APIs has two new commands, `MAKE_COMPONENT_SUSPENDED` and `MAKE_COMPONENT_ENTERED`, which makes it easy to suspend a component. These commands are useful when working in an API with many calculations.

The commands set the status of components to be *suspended* or *entered* in the POLY module in Console Mode. The result is otherwise identical to suspending/entering components with the `CHANGE_STATUS` command, except that any existing conditions that depend on a suspended component are removed when using `MAKE_COMPONENT_SUSPENDED`.

These commands are useful when an element has a very low amount because you can now ignore the element in the calculation instead of reading the entire system from the database, which can save a lot of time. Additionally, calculations can fail when using small amounts as conditions, but they will not fail when the components are suspended.

## Gibbs Energy System (GES6) - PARROT Optimization Supported

Starting with Thermo-Calc version 2019b, the part of the calculation engine known as the Gibbs Energy System module, or GES for short, was updated from version 5 (GES5) to version 6 (GES6). GES6 is now enabled by default.

The PARROT optimization module in Console Mode previously required the use of GES5 for software versions 2019b and 2020a. As of 2020b (this release) PARROT is set to use GES6 by default.





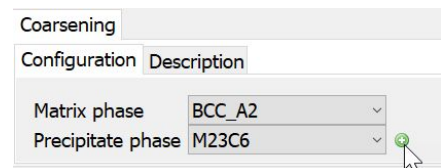
For further information about the changes to GES, see the [2019b release notes on our website](#).

## Thermo-Calc Improvements and Bug Fixes

### Property Models and the Property Model Calculator

*These items are applicable to Graphical Mode.*

- Fixed an issue where you could not save results for a single point calculation.
- The Interfacial Energy Model used slightly wrong u-fractions if carbon or nitrogen were in the system.
- Fixed an issue when setting matrix phase with composition sets.
- The Coarsening Model potentially used the wrong u-fractions if carbon or nitrogen were in the system.
- The Coarsening Model can now handle multiple precipitating phases. Use the **Add**  and **Remove**  buttons on the **Configuration** window to do this.



### Plots

- Fixed a Graphical Mode bug in grouped plotting mode. Previously when changing the plot unit it would lock the **Configuration** window and display a warning in error.

- For Graphical Mode when using the Experimental File Reader, fixed a bug with the **Retain labels** button where it if was not selected on the Plot Renderer then the symbols were not correctly appended to the plot.
- In Graphical Mode, fixed a bug when using the Diffusion Calculator where plot conditions could not be specified in Advanced mode.

## General Warnings

- Fixed a general issue in Graphical Mode with entering information into a field where a numerical value is required and text is entered instead. Now if an invalid value is entered, all double or integer fields have a red border and an error-tooltip to help guide the user to enter the correct information.
- For both Console Mode and Graphical Mode, the **Event Log** now displays warnings in orange and errors in red. Previously both were in red text making it difficult to visually see the differences quickly.

## Miscellaneous

- Limits for KAPOOR-FROHBERG SLAG MODEL is increased. In version 2020a, the model is dimensioned for 6 anions, 20 components in phase, and 30 species. For version 2020b, the model is dimensioned for 6 anions, 50 components in phase, and 200 species.
- In Console Mode, the SAVE\_WORKSPACES command in POLY saved a file with the default file name, even if a custom name had already been given, if the command SAVE, , Y was issued.
- Corrected the second derivatives of the Einstein model contribution to the Gibbs energy (Chen & Sundman Journal of Phase Equilibria, 22(6):631-644,2001).
- GES5-files can be saved even in GES6 mode in the Gibbs Energy Module in the console.

## New Thermodynamic Databases with Thermophysical Properties



Read more in these release notes about the new [Thermophysical Properties Available](#). The three databases in this section have the properties data as indicated.

### TCAL7 TCS AI-based Alloy Database

#### New Thermophysical Properties

- Electrical resistivity is modeled for crystalline phases and liquid. The descriptions can be used for deriving electrical conductivity.
- Thermal conductivity is modeled for crystalline phases and liquid. The descriptions can be used for deriving thermal resistivity as well as thermal diffusivity (by combining with our density and heat capacity data).
- Viscosity and surface tension of liquid are modeled.

## New Elements and Systems

- Added new minor-alloying elements: Nb, P and Y.
- Al-P, P-Si, P-Zn, Al-P-Si, and Al-P-Zn are modeled. The systems help to predict the formation of the ALP phase in aluminum alloys and to interpret its impacts on the microstructure modification.
- Al-Nb, as well as Nb-Ti and Al-Nb-Ti, is modeled for the minor-alloying element Nb.
- Al-Y, as well as Ti-Y and Al-Ti-Y, is modeled for the minor-alloying element Y.
- Six more Al-containing ternary systems are modeled, Al-C-Cr, Al-C-Mg, Al-C-V, Al-Cr-Mg, Al-Mg-Ti, and Al-Si-Sr, to make the Al-rich multi-component description more complete.

## New Metastable Phase

- The semi-coherent version of the quaternary Q\_ALCUMGSI phase is modeled as a metastable phase, QPRIME. It is expected to be used in precipitation simulations.

## Updated Systems and Phases

- Al-C is updated taking into account the most recent modeling work.
- Si-Sr is updated and now reproduces the most recent modeling work.
- Al-C-Si is updated with the improved Al-C binary description.
- Al-Sc-Si is updated by modeling the Si solubility in the AL3X (Al<sub>3</sub>Sc-based) phase, which is a strengthening precipitate in some aluminum alloys
- Al-Fe-Mg-Si: the quaternary phase  $\pi$ -AL18FE2MG7SI10 is refined to make better predictions for solidification and lower temperature heat treatments of related aluminum alloys.
- Al-Fe-Mn-Si is updated by modeling the Mn solubility in AL8FE2SI.
- Cr and Mo are introduced to the Al<sub>15</sub>Si<sub>2</sub>M<sub>4</sub> (M = Cr, Fe, Mn and Mo) phase, which is of industrial importance in Al-Mn-Si and Al-Fe-Mn-Si based alloys.

## TCOX10 TCS Metal Oxide Solutions Database

### New Thermophysical Properties

- Added/assessed molar volumes to the database, both for solid and liquid oxides and metals.
- Assessed viscosity for the liquid oxides. Included oxides: FeO, Fe<sub>2</sub>O<sub>3</sub>, CaO, MgO, Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, CaF<sub>2</sub>, Cr<sub>2</sub>O<sub>3</sub>, Na<sub>2</sub>O, MnO, TiO<sub>2</sub>, ZrO<sub>2</sub>, P<sub>2</sub>O<sub>5</sub>, Gd<sub>2</sub>O<sub>3</sub>, La<sub>2</sub>O<sub>3</sub>, V<sub>2</sub>O<sub>5</sub>, NiO, CuO<sub>x</sub>.

### New Elements

- Addition of three new elements: N, Na, H (Hydrogen only in gas).

### Binary, Ternary and Higher Order System Updates

- N: Added description of 17 binary and 28 ternary systems. Nitrogen is only assessed in metallic systems, so for example SiAlONs are not described in this database.
- Na: Assessed or added from literature eight binary metallic systems. Added Na-O from literature and assessed the Na-S system. Assessed eight ternary Me-Na-O and 11 higher order oxide systems.
- These systems are assessed: C-Ca-O and C-Mg-O.

- These systems are reassessed: Cr-O, Ca-Cr-O, Cr-Si-O, Ca-Cr-Si-O.
- Minor changes to these systems: Co-Ni-O, Co-Fe-Ni-O, Co-Fe-Ti-O, Mo-O, Al-Mo-O, Mg-Mo-O, Mn-Mo-O, Mo-Ni-O, Nb-O, La-P-O, P-Zr-O, Ti-Zr-O.
- Assessed a separation between liquid metal and SiO<sub>2</sub> in these Me-O-Si systems: Me = Ca, Gd, La, Mg, Mo, Nb, Ni, P, Ti, V, W, Y, Zr.

## Other Updates and Improvements

- H: Added H, H<sub>2</sub>, C<sub>1</sub>H<sub>4</sub> and H<sub>2</sub>O to the gas phase.
- Reassessed the vacancy fraction on the FCC metallic sublattice to get a V<sub>a</sub>-fraction of 1e-5 at liquidus (this was earlier 1e-4).

## TCNI10 TCS Ni-based Superalloys Database

### New Thermophysical Properties

- Surface tension for the liquid phase is assessed in all unary and binary systems.
- Viscosity for the liquid phase is assessed in all unary and 142 binary systems.

### Binary and Unary System Updates

- Nb-Ni metastable BCT\_D022 updated to fit data on  $\gamma''$  solvus temperature in commercial superalloys.
- The solubility of S in  $\gamma$ -Ni has been assessed.
- Bug fix - metastable BCT\_D022 destabilized in Cr-Nb and pure Cr to avoid low-temperature metastable miscibility gaps.

### Ternary System Updates

- Al-Co-W system was updated to fit better experimental data and no longer has stable L12 at 900 °C.
- Al-Hf-Ni system revised to better describe liquidus, solidus, and liquid activity as well as  $\gamma'$  boundaries and activity.
- Al-Ni-Pt system updated to better describe liquid activity and melting interval data.
- Al-Ni-W system revised to better fit the known melting interval and improve liquid/ $\gamma$  partitioning in higher-order alloys.
- Co-Hf-Ni liquid and  $\gamma$  phases updated to better describe the melting intervals of high-Co Ni-base alloys.
- Co-Ni-W system updated to fit more recent data on the varying ternary solubility of the ALT13\_D019 phase.
- Co-Ni-V has been partially assessed by adding Co to BCT-D022, and FCC and liquid have been adjusted to give approximate isothermal and isoplethal sections.
- Nb-Ni-Ti system modified to be closer to the known phase diagram.

### Ternary System Bug Fixes

- L12 destabilized in Cr-Ni-W and Cr-Ni-Si.
- ALT13\_D019 destabilized in Cr-Ni-W.
- Corrected M4Si3 in Cr-Ni-Si, now metastable in Cr-Si and Ni-Si.



- Corrected M5Si3\_D88 in C-Cr-Si.
- Al-Cr-Pt extrapolation corrected.

## Quality Improvements

- The `DATABASE_INFORMATION` command accessed via the `DATABASE` module in Console Mode now includes an exact revision number to make it easier to communicate support questions.
- The additional phase information now contains crystallographic information (if known) for all phases. The command is invoked in the `DATABASE` module using the `LIST_SYSTEM` and `CONSTITUENTS` commands.
- The database is automatically validated against a large range of commercial and model alloys to verify that every revision improves solidus, liquidus,  $\gamma'$  solvus and liquid/solid partitioning data. This ensures that no alloy should fall through the cracks.

## Phase Renaming

- `ALTI3_DO19` name (where **O** is a letter) is changed to `ALTI3_D019` (where **0** is zero), which is consistent with the Strukturbericht designation. Users are advised to update their macros involving this phase.



## Updated Thermodynamic Databases

### TCHEA4 TCS High Entropy Alloy Database (Version 4.1)

- Crystal structure information is included for all phases.
- HCP\_ZN is merged into HCP\_A3. The epsilon phase with HCP structure in the Cu-Zn, Mn-Zn and Cu-Mn-Zn systems is separated from HCP\_A3 and renamed as CUMNZN\_EPSILON\_HCP.
- Better estimation of excess energy for metastable solution phases and compound energy for metastable end-members in binary systems.

### TCTI2 TCS Ti/TiAl-based Alloys Database (Version 2.2)

Improved description of liquid phase for calculations with yttrium.

### TCSLD3 TCS Solder Alloy Solutions Database (Version 3.3)

Added three binary systems Ga-Bi, Ga-Sb and Ga-In.

### TCFE10 and TCFE9 TCS Steel and Fe-alloys Database

There was a simultaneous update to both TCFE9 and TCFE10 that is bundled with the 2020b software release and needed for the Steel Model Library, Martensite Temperature Model.

#### TCFE10 to TCFE10.1

- Revised parameters of BCC\_A1 phase in Fe-Mn-N and Fe-W-N systems to avoid the appearance of a high N composition set at low temperatures with tie lines extending to the Fe-corner.
- Removed a previously added ad-hoc modification to the lattice stability of BCC\_A1 Nickel at temperatures below 450K.

#### TCFE9.1 to 9.2

- Removed a previously added ad-hoc modification to the lattice stability of BCC\_A1 Nickel at temperatures below 450K.

### TCAQ3 TCS Aqueous Solution Database (Version 3.1)

Minor bug fix for the confusing notation "HF" for both the element and the aqueous species.

### GCE2 TCS Geochemical Environmental Database (Version 2.4)

The SUPERFLUID phase is excluded in the database, plus some minor bug-fixes.

## TC-Python API

### New Features

On the System class it is now possible to:

- Select, deselect and create species
- Create composition sets
- Select/deselect major constituents on sublattices
- Get database references

The functionality for listing, viewing, adding and changing GES parameters and functions is rewritten and expanded. The following is available only for unencrypted databases.

- Now you can list and view all GES parameters and functions by using the new class `SystemData` which you get from the function `get_system_data` on the System class.
- Now it's possible to list, view, add and change GES parameters and functions on all Calculation classes by using the new classes `SystemData` and `SystemModifications` which you get from the function `get_system_data` and set with the function `with_system_modifications`.

Some of this functionality existed in earlier versions of TC-Python directly in the System class, and will still exist in this and coming versions until 2021b. We encourage users to switch to the new classes.

### Removed Scheil Calculation Options

Calculation options for Scheil, marked for depreciation since 2019b, are removed from the `ScheilCalculation` class. These can be found in the class `ScheilOptions`. This is a breaking change.



You can search the TC-Python Help, which is available with your installation and on the [Support area of the website](#). Also see the [product page on the website](#) for more information about the key features including an installation video.

## Documentation

### New Database Technical Information and Examples Collections PDFs

As new databases are being released and updated to include the [Thermophysical Property Data: Viscosity, Surface Tension and More](#), the technical documentation is also being improved to include this information as well as provide more examples.

This means that there will be a gradual change to the PDF documentation available on the website and included with the installation. All the technical documentation continues to be in the Help, but the original documents called *Extended Information* (which contain examples) are being replaced by two documents, one called *Technical Information* and one called *Examples Collection*. The *Examples Collection* PDF is only available on the website or as part of the Help and some examples in the future will only be available on the website.

This change is applicable in 2020b to the following databases that are detailed in the respective sections.

- [TCAL7 TCS Al-based Alloy Database](#)
- [TCOX10 TCS Metal Oxide Solutions Database](#)
- [TCNI10 TCS Ni-based Superalloys Database](#)
- [TCHEA4.1 TCS High Entropy Alloy Database](#)
- [TCSLD3.3 TCS Solder Alloy Solutions Database](#)

*\*\*Note that the TCHEA4 database had viscosity of liquid included as of 2020a, but that the TCSLD3 database has not had any new properties added.*



To learn more about the examples and technical information, either search the Help for “about the database examples” or visit our website [Database section](#) where links to all the PDFs are available.

## New Examples

- The Precipitation Module (TC-PRISMA) has an updated example to demonstrate the new yield strength model. See [Updated Example includes Yield Strength](#).
- The Process Metallurgy Module has [Three New Process Metallurgy Examples](#).
- The new thermophysical properties, viscosity of liquid and surface tension of liquid, have new examples available in Console Mode and Graphical Mode. See [New Examples in Thermo-Calc and with the Databases](#).
- As discussed, there are new plot diagram examples for the new and some of the updated databases available in the Help and on the website.



Many of our Graphical Mode examples have video tutorials, which you can access in a variety of ways. When in Thermo-Calc, from the menu select **Help → Video Tutorials**, or you can go to the [website](#) or our [YouTube channel](#).

## Installation

### Updating TC-Python from 2020a to 2020b

Note the following if you installed earlier versions of TC-Python with Thermo-Calc. When updating to a newer version of Thermo-Calc, you **always also need to install the latest version of TC-Python**. It is not sufficient to run the installer of Thermo-Calc. See the section *Updating to a newer version* in the [TC-Python HTML Help](#) on the web, or the [PDF](#) version.

### Installation Disk Space Requirement

As a general requirement, 2 GB of disk space is required for installation and 8 GB of RAM is recommended for reasonable performance. Furthermore, a minimum of 50 GB of free disk space and preferably use of an SSD (solid state disk) is recommended for running Thermo-Calc and its SDKs. Not all calculation types require this much free disk space, but some rely heavily on saving and reading files from the hard drive, particularly Process Metallurgy Module calculations.

## Platform Roadmap

For information about platforms being phased out visit <http://www.thermocalc.com/products-services/software/system-requirements/platformroadmap/>.