Glossary of Terms Related to Solubility

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Introduction

Disciplines concerned with solubility phenomena extend well beyond the traditional branches of chemistry to a wide range of bio-medical, environmental, and industrial fields. The diversity in the training of individuals concerned with solubility heightens the potential for confusion of both concepts and data related to solubility. This glossary seeks to reduce such confusion by presenting ca 160 solubility related terms that are consistent with IUPAC recommendations for chemical terminology, quantities, units and symbols.

The contents of this project are illustrated by presentation of six selected solubility-related terms of theoretical and practical relevance along with their definitions. The terms include the following topics:

- Physico-chemical aspects: phase theory; freezing point depression, determination of molecular mass and number of dissociation products.
- Technological aspects: temperature, concentration curve of road anti-icing or de-icing chemicals, freezing range of solders, design of lead-free solder alloys.
- Modeling aspects: base data for geochemical and hydrometallurgical models.

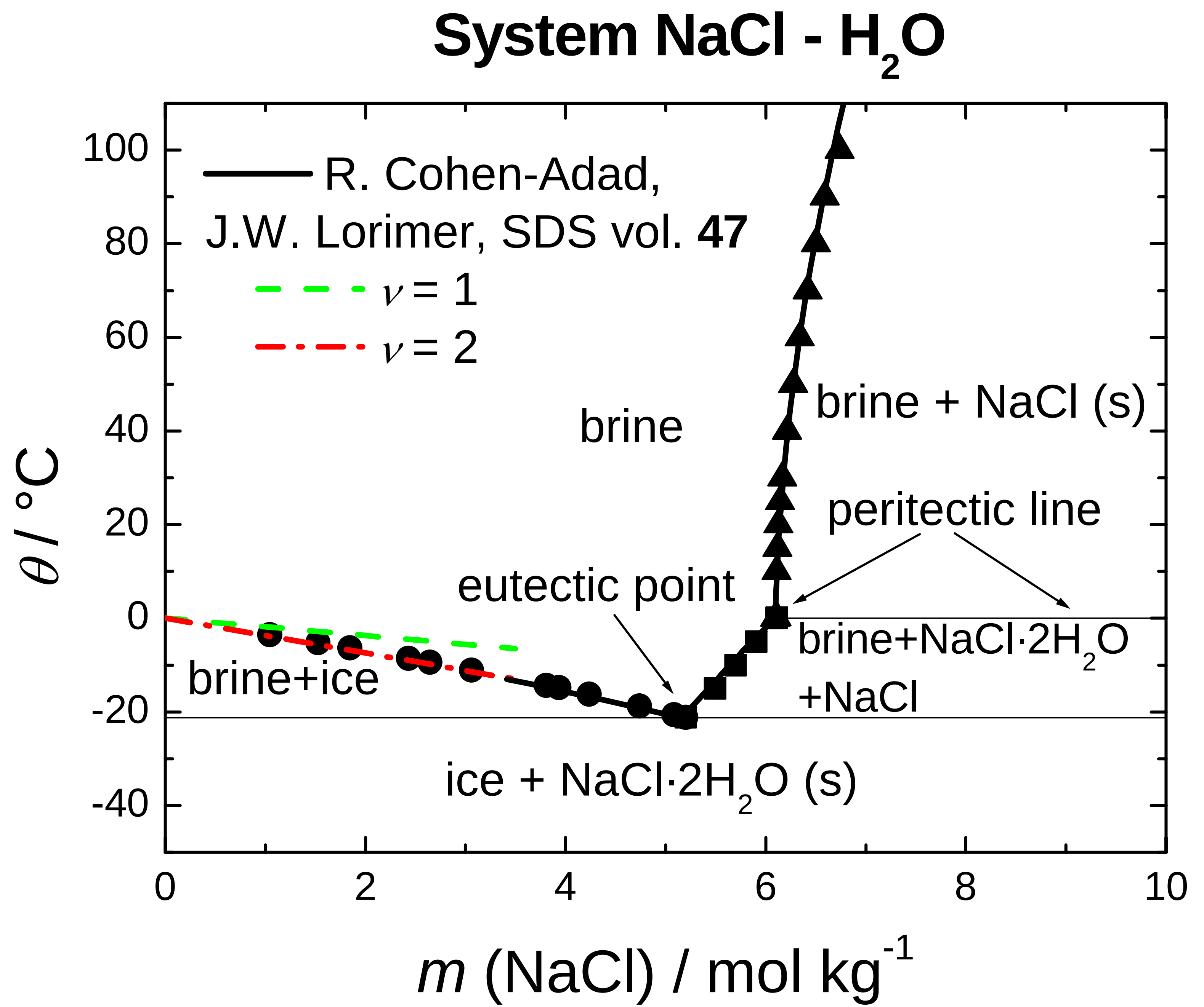
Water – ice equilibrium in solutions

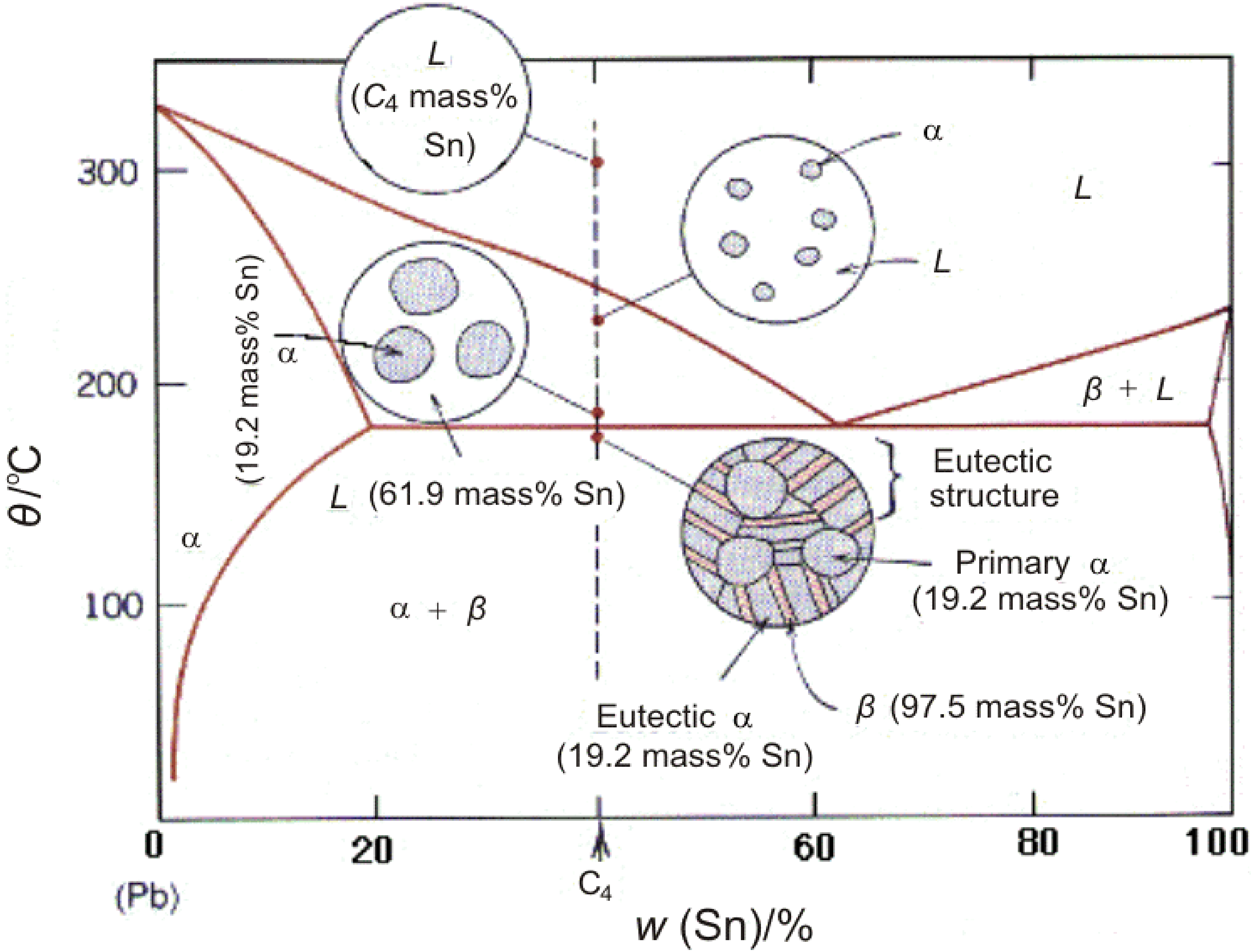
$$\mu^*(H_2O, l) + RT \ln a(H_2O) = \mu^*(H_2O, s)$$

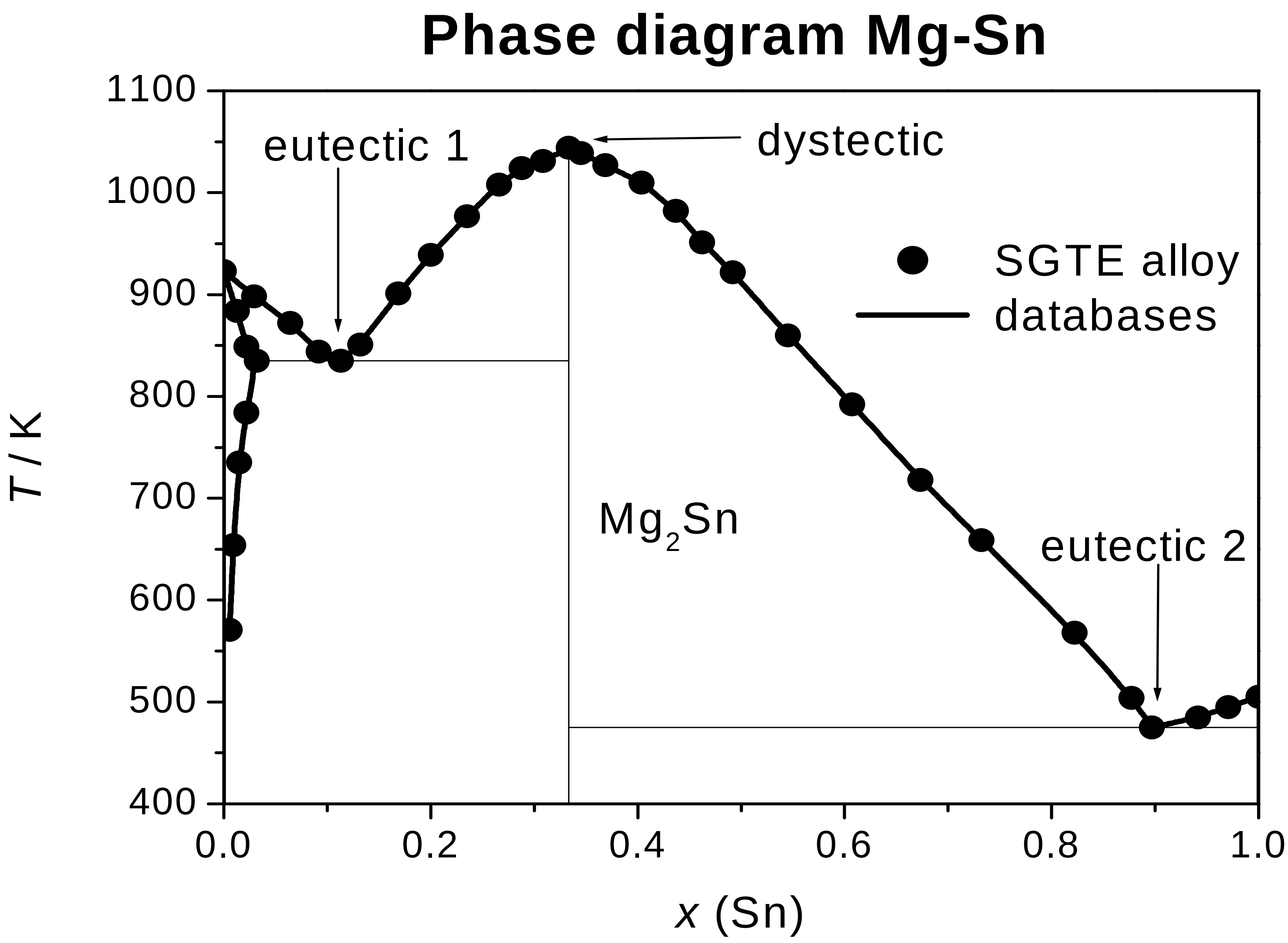
$$-\ln a(H_2O) = \frac{\Delta_{fus} H^*\left(H_2O\right)}{R}\left(\frac{1}{T} - \frac{1}{T^*}\right)$$

$$v \cdot m \cdot M\,(H_2O) \cdot \Phi \approx -\frac{\Delta_{fus} H^*\left(H_2O\right)}{RT^{*2}} \Delta T$$

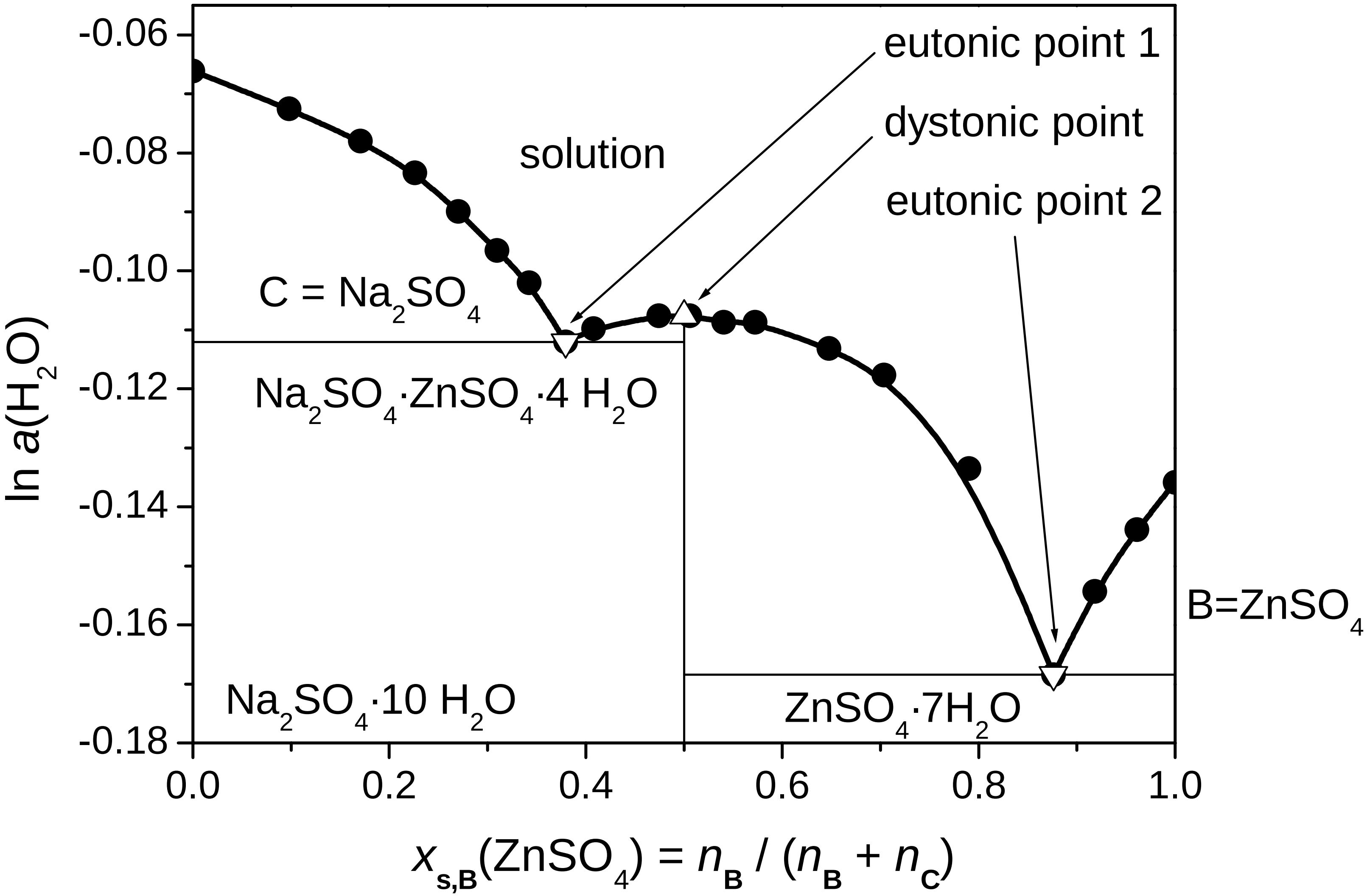
$$\Delta T \approx -\,(1.86\ /\ K \cdot mol^{-1} \cdot kg) \cdot v \cdot m$$


System NaCl - H2O
R. Cohen-Adad,
J.W. Lorimer, SDS vol. 47
ν = 1
ν = 2
brine
brine + NaCl (s)
peritectic line
eutectic point
brine+NaCl·2H2O
+NaCl
brine+ice
ice + NaCl·2H2O (s)
θ / °C
m (NaCl) / mol kg-1
100
80
60
40
20
0
-20
-40
0
2
4
6
8
10

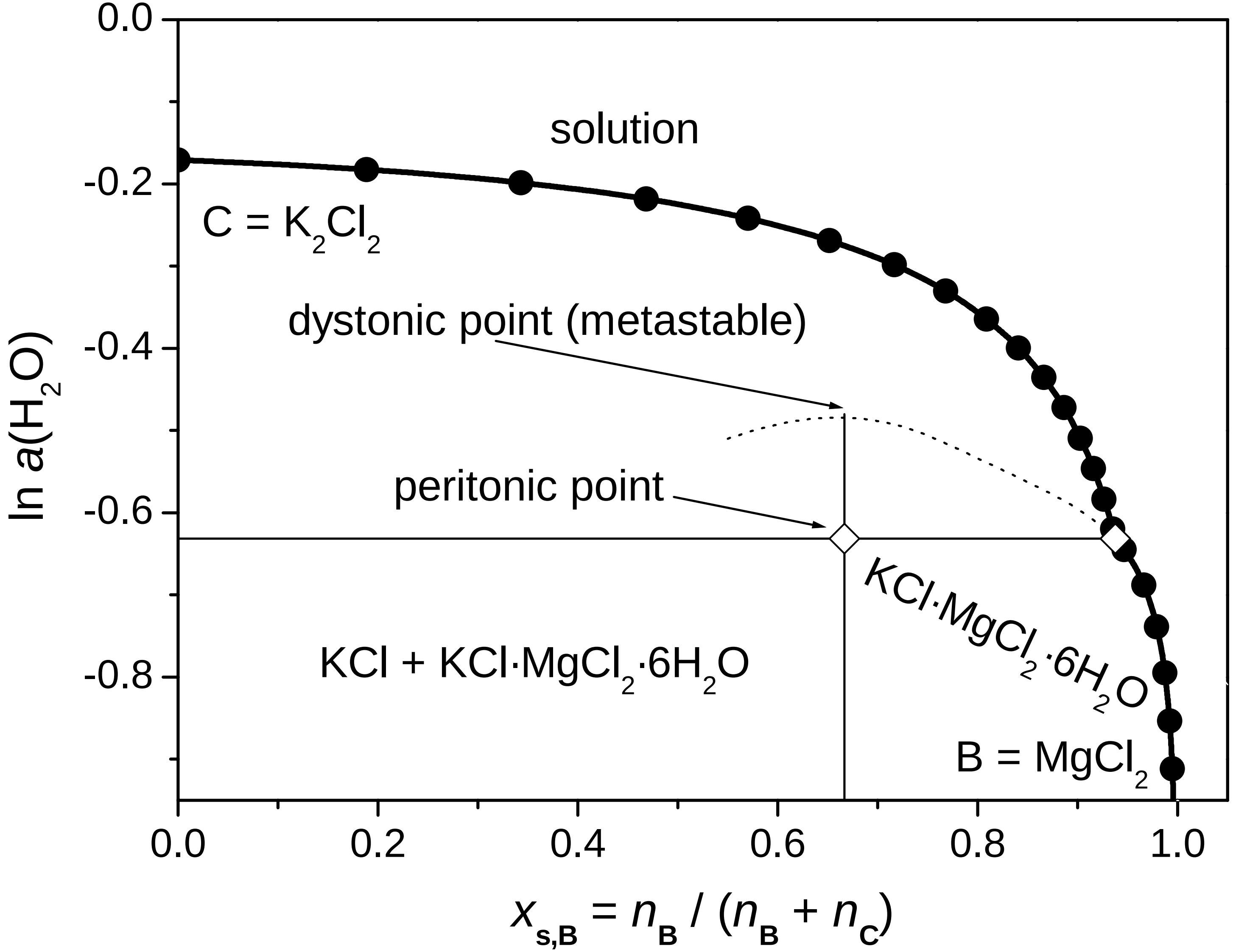

L
(C4 mass% Sn)
α
L
(19.2 mass% Sn)
α
L (61.9 mass% Sn)
β + L
Eutectic structure
Primary α (19.2 mass% Sn)
α
α + β
Eutectic α (19.2 mass% Sn)
β (97.5 mass% Sn)
300
200
100
θ/°C
0
20
60
80
100
(Pb)
C4
w (Sn)/%


Phase diagram Mg-Sn
1100
1000
900
800
700
600
500
400
T / K
0.0
0.2
0.4
0.6
0.8
1.0
x (Sn)
eutectic 1
dystectic
SGTE alloy
databases
Mg2Sn
eutectic 2

Solubility diagram Na_2SO_4 - $ZnSO_4$ - H_2O



Solubility diagram KCl - $MgCl_2$ - H_2O



36. eutectic reaction

From the Greek ευτηκτος, easy (or lowest) melting.

Isothermal reversible reaction of a liquid *phase* l which is transformed into two (or more) different solid phases α and β during the cooling of a *system*. In a binary system:

$$l \rightleftharpoons \alpha + \beta$$

where l is a liquid phase, α, β are solid phases and the forward arrow indicates the direction of cooling. The *equilibrium* reaction occurs along the eutectic line at the eutectic (minimum) temperature. At the eutectic composition, the composition of the liquid and solid phases are equal, and intermediate to the compositions of the solid phases of the system.

33. dystectic reaction

Greek: δύστηκτος, difficult (or highest) melting

Isobaric, reversible melting or *dissolution* with either complete or partial dissociation on heating of a solid compound, A_aB_b, formed by *components* A and B:

$$A_aB_b(s) \rightleftharpoons A_aB_b(l) \rightleftharpoons aA(l) + bB(l)$$
$$Mg_2Sn(s) \rightleftharpoons Mg_2Sn(l) \rightleftharpoons 2Mg(l) + Sn(l)$$

where the forward arrow indicates the direction of heating. The dystectic temperature is a maximum ($\mathrm{d}T / \mathrm{d}x = 0$) of the melting temperature - composition curve.

91. peritectic reaction

Greek: περι- = around and -τηκτος = fusible.

incongruent reaction

Isothermal, reversible reaction between two phases, a liquid and a solid, that results, on cooling of a *binary, ternary* or *higher-order system* in one, two, … ($n - 1$, where n is the number of *components*) new solid *phases*. For example, in a binary system

$$l + \alpha \rightleftharpoons \beta$$

where the forward arrow indicates the direction of cooling. The *equilibrium* process occurs along the peritectic line, characterized by the peritectic temperature. The peritectic composition and temperature, isobaric invariants of the system, define the peritectic point, which lies between the compositions of phases l and α.

38. eutonic reaction

Greek: ευτονος, easy (or lowest) tension (or vapor pressure).

(isothermally and isobarically invariant) reaction of double saturation. Reversible isoplethic *dissolution* in a *system* of three or more *components* characterized by the composition of a *solution* that is simultaneously saturated with respect to all (at least two or more) dissolved *solutes*. The two simultaneous equilibrium processes are, for example:

$$\mathrm{A}\cdot p\mathrm{H_2O} \rightleftharpoons \mathrm{A(aq,\ sat)} + p\mathrm{H_2O(l)}$$
$$\mathrm{B}\cdot q\mathrm{H_2O} \rightleftharpoons \mathrm{B(aq,\ sat)} + q\mathrm{H_2O(l)}$$

34. dystonic reaction

Greek: δύστονος, difficult (highest) tension (vapor pressure)
congruent dissolution

Reversible *dissolution* in an isothermal, isobaric *system* of three or more *components* characterized by congruent dissolution of *solutes* and *saturation* with a stoichiometric compound consisting of two or more of these components. The *equilibrium* process is, for example:

$$AB \cdot pH_2O \rightleftharpoons A(aq, sat) + B(aq, sat) + pH_2O(l)$$

$$Na_2SO_4 \cdot ZnSO_4 \cdot 4H_2O \rightleftharpoons Na_2SO_4(aq, sat) + ZnSO_4(aq, sat) + 4H_2O(l)$$

93. peritonic reaction

Isothermal, isobaric, isoplethic reversible reaction between two phases, a saturated liquid and a solid, that results, on removal of the solvent *component* of a *ternary system* in one new solid *phase*. For example:

$$l + \alpha \rightleftharpoons \beta$$

where the forward arrow indicates the direction of removal of the solvent component. The *equilibrium* process occurs along the peritonic line, characterized by the peritonic composition or point, an isothermal isobaric invariant of the system which lies between the compositions of phases l and α. The equilibrium process is, for example:

$$AX \cdot pH_2O(s) + B^{z+}(aq,sat) + (q-p)H_2O(l) \rightleftharpoons BX \cdot qH_2O(s) + A^{z+}(aq,sat)$$

Named from a combination of eutonic and peritectic.