Introduction

Data Covered

The series focuses on light metal ternary systems and includes phase equilibria of importance for alloy development, processing or application, reporting on selected ternary systems of importance to industrial light alloy development and systems which gained otherwise scientific interest in the recent years.

General

The series provides consistent phase diagram descriptions for individual ternary systems. The representation of the equilibria of ternary systems as a function of temperature results in spacial diagrams whose sections and projections are generally published in the literature. Phase equilibria are described in terms of liquidus, solidus and solvus projections, isothermal and pseudobinary sections; data on invariant equilibria are generally given in the form of tables.

The world literature is thoroughly and systematically searched back to the year 1900. Then, the published data are critically evaluated by experts in materials science and reviewed. Conflicting information is commented upon and errors and inconsistencies removed wherever possible. It considers those, and only those data, which are firmly established, comments on questionable findings and justifies re-interpretations made by the authors of the evaluation reports.

In general, the approach used to discuss the phase relationships is to consider changes in state and phase reactions which occur with decreasing temperature. This has influenced the terminology employed and is reflected in the tables and the reaction schemes presented.

The system reports present concise descriptions and hence do not repeat in the text facts which can clearly be read from the diagrams. For most purposes the use of the compendium is expected to be self-sufficient. However, a detailed bibliography of all cited references is given to enable original sources of information to be studied if required.

Structure of a System Report

The constitutional description of an alloy system consists of text and a table/diagram section which are separated by the bibliography referring to the original literature (see Fig. 1). The tables and diagrams carry the essential constitutional information and are commented on in the text if necessary.

Where published data allow, the following sections are provided in each report:

Literature Data

The opening text reviews briefly the status of knowledge published on the system and outlines the experimental methods that have been applied. Furthermore, attention may be drawn to questions which are still open or to cases where conclusions from the evaluation work modified the published phase diagram.

Binary Systems

Where binary systems are accepted from standard compilations reference is made to these compilations. In other cases the accepted binary phase diagrams are reproduced for the convenience of the reader. The selection of the binary systems used as a basis for the evaluation of the ternary system was at the discretion of the assessor.

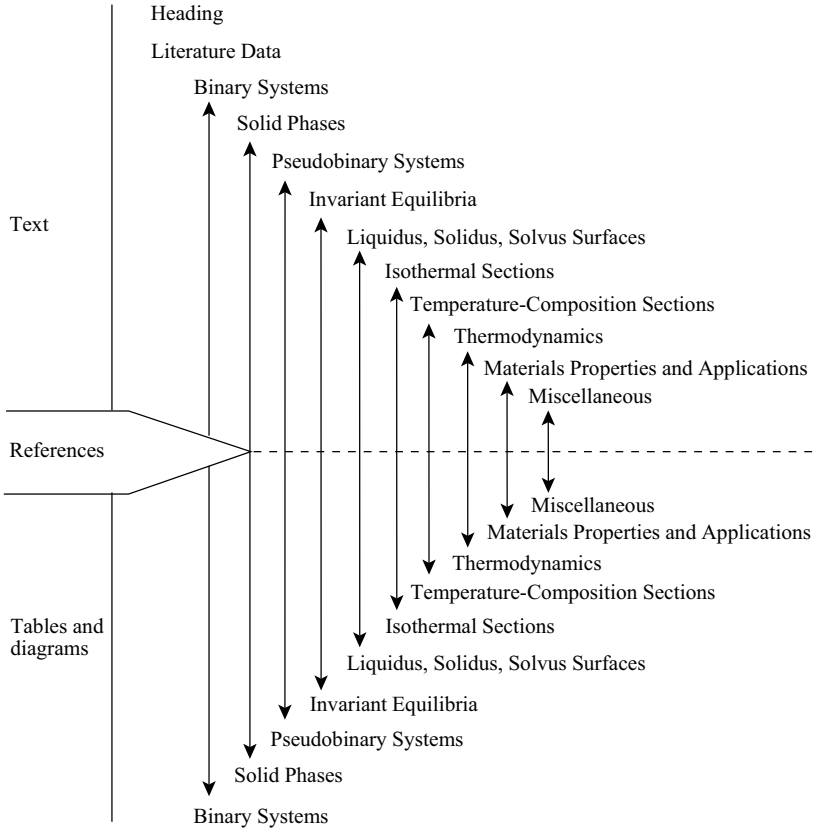

Fig. 1: Structure of a system report

Solid Phases

The tabular listing of solid phases incorporates knowledge of the phases which is necessary or helpful for understanding the text and diagrams. Throughout a system report a unique phase name and abbreviation is allocated to each phase.

Phases with the same formulae but different space lattices (e.g. allotropic transformation) are distinguished by:

– small letters (h), high temperature modification ($h_2 > h_1$)
(r), room temperature modification
(1), low temperature modification ($l_1 > l_2$)

– Greek letters, e.g., ε, ε'

– Roman numerals, e.g., (I) and (II) for different pressure modifications.

In the table "Solid Phases" ternary phases are denoted by * and different phases are separated by horizontal lines.

Pseudobinary Systems

Pseudobinary sections describe equilibria and can be read in the same way as binary diagrams. The notation used in pseudobinary systems is the same as that of vertical sections, which are reported under "Temperature-Composition Sections".

Invariant Equilibria

The invariant equilibria of a system are listed in the table "Invariant Equilibria" and, where possible, are described by a constitutional "Reaction Scheme" (Fig. 2).

The sequential numbering of invariant equilibria increases with decreasing temperature, one numbering for all binaries together and one for the ternary system.

Equilibria notations are used to indicate the reactions by which phases will be

– decomposed (e- and E-type reactions)
– formed (p- and P-type reactions)
– transformed (U-type reactions)

For transition reactions the letter U (Übergangsreaktion) is used in order to reserve the letter *T* to denote temperature. The letters d and D indicate degenerate equilibria which do not allow a distinction according to the above classes.

Liquidus, Solidus, Solvus Surfaces

The phase equilibria are commonly shown in triangular coordinates which allow a reading of the concentration of the constituents in at.%. In some cases mass% scaling is used for better data readability (see Figs. 3 and 4).

In the polythermal projection of the liquidus surface, monovariant liquidus grooves separate phase regions of primary crystallization and, where available, isothermal lines contour the liquidus surface (see Fig. 3).

Isothermal Sections

Phase equilibria at constant temperatures are plotted in the form of isothermal sections (see Fig. 4).

Temperature – Composition Sections

Non-pseudobinary *T-x* sections (or vertical sections, isopleths, polythermal sections) show the phase fields where generally the tie lines are not in the same plane as the section. The notation employed for the latter (see Fig. 5) is the same as that used for binary and pseudobinary phase diagrams.

Thermodynamics

Experimental ternary data are reported in some system reports and reference to thermodynamic modelling is made.

Notes on Materials Properties and Applications

Noteworthy physical and chemical materials properties and application areas are briefly reported if they were given in the original constitutional and phase diagram literature.

Miscellaneous

In this section noteworthy features are reported which are not described in preceding paragraphs. These include graphical data not covered by the general report format, such as lattice spacing – composition data, *p-T-x* diagrams, etc.

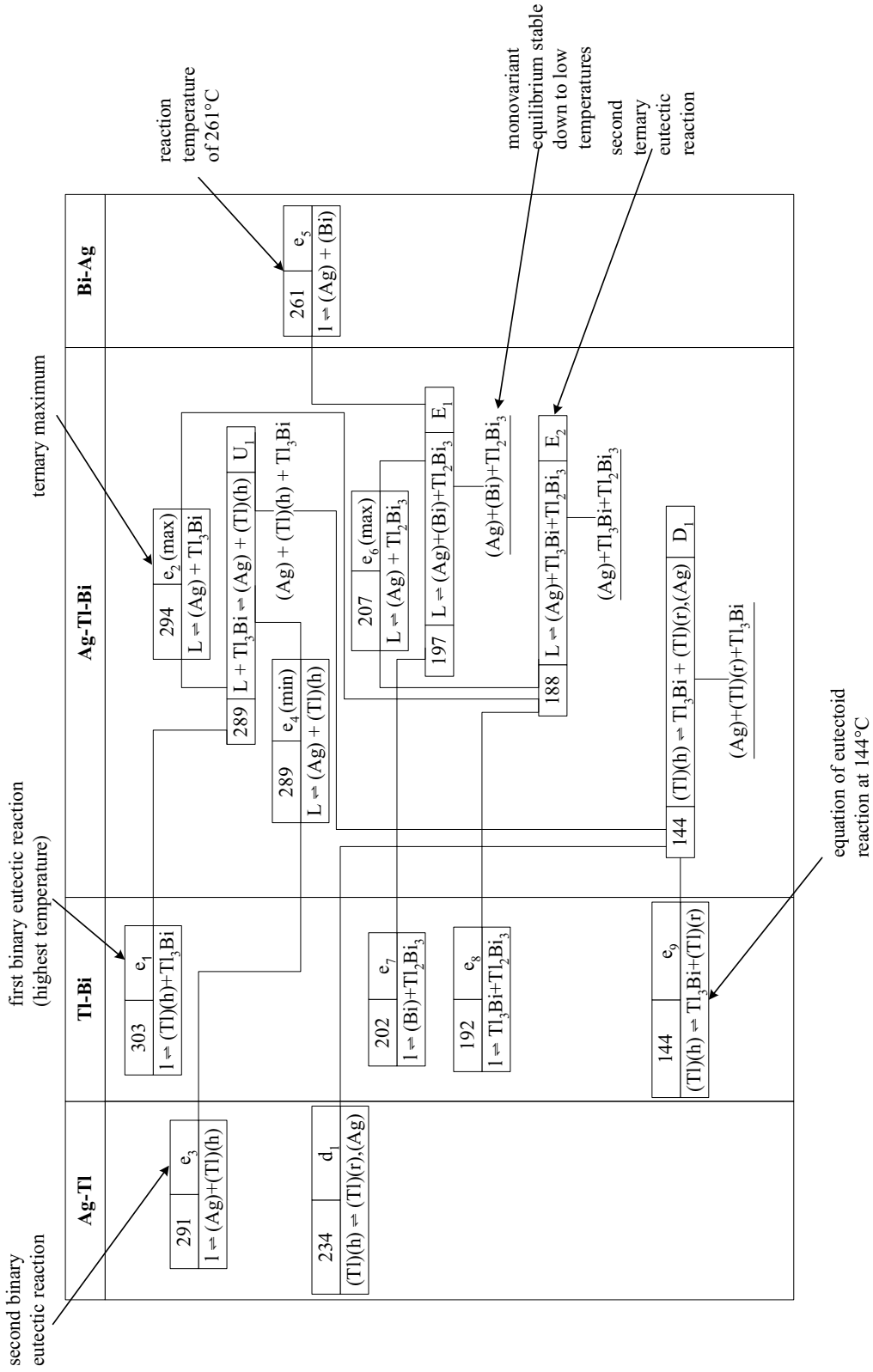

Fig. 2: Typical reaction scheme

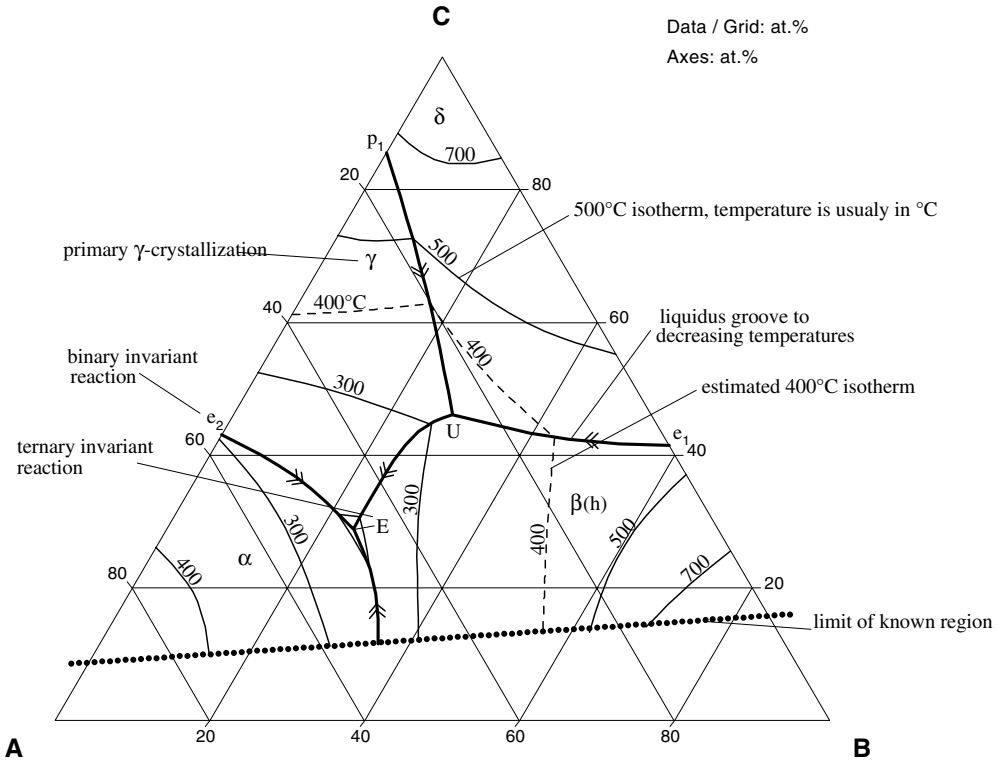

Fig. 3: Hypothetical liquidus surface showing notation employed

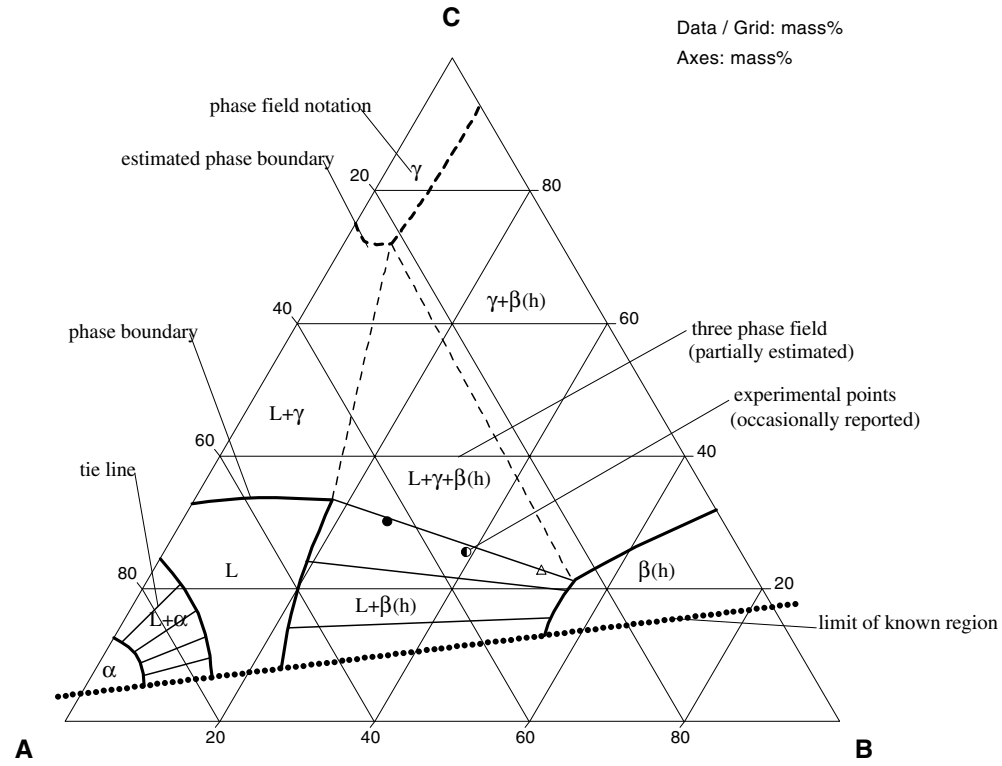

Fig. 4: Hypothetical isothermal section showing notation employed

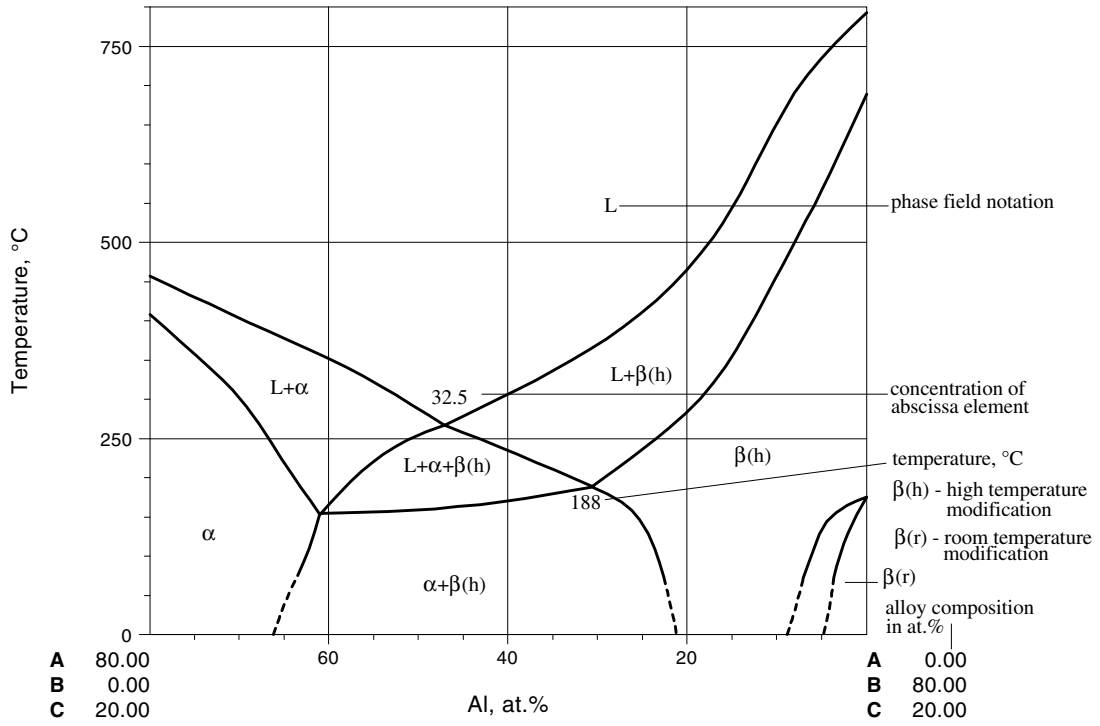

Fig. 5: Hypothetical vertical section showing notation employed

References

The publications which form the bases of the assessments are listed in the following manner:

[1974Hay] Hayashi, M., Azakami, T., Kamed, M., "Effects of Third Elements on the Activity of Lead in Liquid Copper Base Alloys" (in Japanese), *Nippon Kogyo Kaishi*, **90**, 51-56 (1974) (Experimental, Thermodyn., 16)

This paper, for example, whose title is given in English, is actually written in Japanese. It was published in 1974 on pages 51- 56, volume 90 of Nippon Kogyo Kaishi, the Journal of the Mining and Metallurgical Institute of Japan. It reports on experimental work that leads to thermodynamic data and it refers to 16 cross-references.

Additional conventions used in citing are:

to indicate the source of accepted phase diagrams

* to indicate key papers that significantly contributed to the understanding of the system.

Standard reference works given in the list "General References" are cited using their abbreviations and are not included in the reference list of each individual system.

General References

[E] Elliott, R.P., *Constitution of Binary Alloys, First Supplement,* McGraw-Hill, New York (1965)

[G] Gmelin *Handbook of Inorganic Chemistry*, 8th ed., Springer-Verlag, Berlin

[H] Hansen, M. and Anderko, K., *Constitution of Binary Alloys*, McGraw-Hill, New York (1958)

[L-B] Landolt-Boernstein, *Numerical Data and Functional Relationships in Science and Technology (New Series). Group 3 (Crystal and Solid State Physics)*, Vol. 6, Eckerlin, P., Kandler, H. and Stegherr, A., *Structure Data of Elements and Intermetallic Phases* (1971); Vol. 7, Pies, W. and Weiss, A., *Crystal Structure of Inorganic Compounds*, Part c, Key Elements: N, P, As, Sb, Bi, C (1979); Group 4: *Macroscopic and Technical Properties of Matter*, Vol. 5, Predel, B., *Phase Equilibria, Crystallographic and Thermodynamic Data of Binary Alloys*, Subvol. a Ac-Au ... Au-Zr (1991); Springer-Verlag, Berlin.

[Mas] Massalski, T.B. (Ed.), *Binary Alloy Phase Diagrams*, ASM, Metals Park, Ohio (1986)

[Mas2] Massalski, T.B. (Ed.), *Binary Alloy Phase Diagrams*, 2nd edition, ASM International, Metals Park, Ohio (1990)

[P] Pearson, W.B., *A Handbook of Lattice Spacings and Structures of Metals and Alloys*, Pergamon Press, New York, Vol. 1 (1958), Vol. 2 (1967)

[S] Shunk, F.A., *Constitution of Binary Alloys, Second Supplement,* McGraw-Hill, New York (1969)

[V-C] Villars, P. and Calvert, L.D., *Pearson's Handbook of Crystallographic Data for Intermetallic Phases*, ASM, Metals Park, Ohio (1985)

[V-C2] Villars, P. and Calvert, L.D., *Pearson's Handbook of Crystallographic Data for Intermetallic Phases,* 2nd edition, ASM, Metals Park, Ohio (1991)