NBS SPECIAL PUBLICATION 564

BINARY PHASE DIAGRAMS OF TRANSITION ELEMENTS

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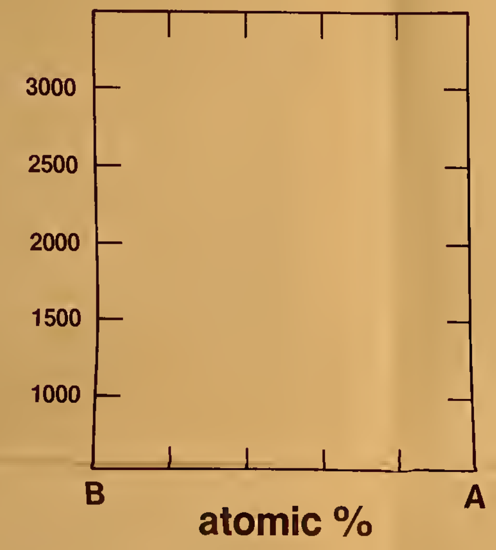
Group B

Mn	Fe	Co	Ni
Tc	Ru	Rh	Pd
Re	Os	Ir	Pt

Group A

Ti	V	Cr
Zr	Nb	Mo
Hf	Ta	W

Format:



Laves-type phases

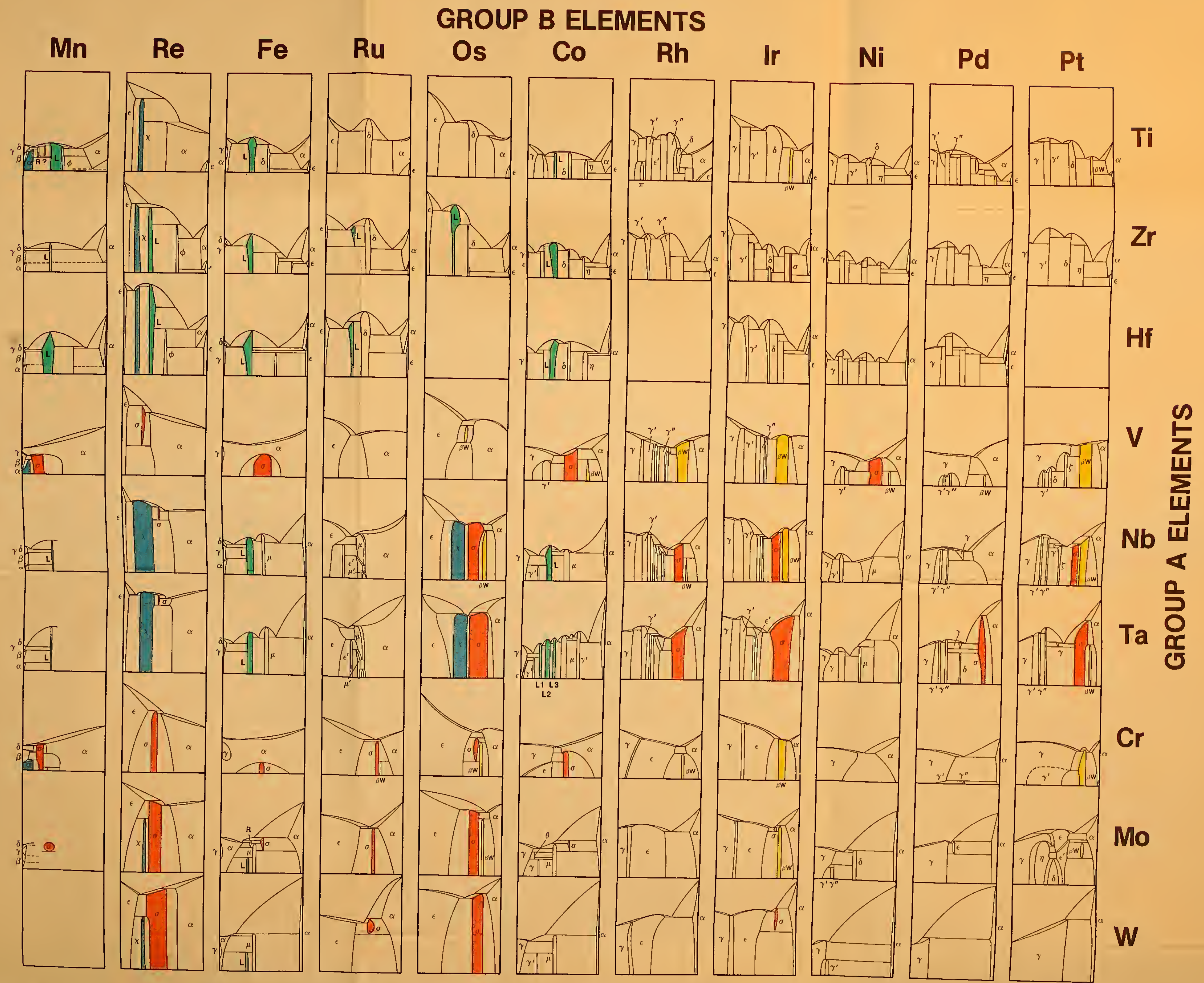
Sigma phases

A15-type phases

αMn-type phases

Nomenclature:

BCC — α FCC — γ HCP — ϵ



SYSTEMATIC RELATIONSHIPS AMONG BINARY PHASE DIAGRAMS OF THE TRANSITION ELEMENTS

The existing compilations of binary phase diagrams generally display each diagram on a separate page. The various systems are then arranged in alphabetical order. This format provides easy access to the phase diagram for any given alloy system. The disadvantage of this format is the user's difficulty in trying to see certain systematic regularities among the various phase diagrams. These regularities originate from fundamental variations in the electronic structures of the constituent elements. It is helpful, therefore, to see the phase diagrams arranged in a format based on the occurrence of the constituent elements in the periodic table. This format enables the user to quickly recognize regularities in the occurrence of particular types of alloy phases with the same or closely-related crystal structures. The user may also see other systematic variations—in the solid solubilities, perhaps, or in the solid-liquid equilibria.

The accompanying color chart is intended to reveal such systematic relationships. However, in order to keep the size of this chart within a reasonable limit, it has been necessary to construct the individual diagrams on a much smaller scale than those which appear in the conventional publications, such as the compilations by Hansen,[1] Elliott,[2] and Shunk,[3]. This significantly decreases accuracy, and the use of this chart for quantitative purposes is not recommended. The chart is intended as a supplement to conventional compilations, aiding in understanding the systematic behavior.

This chart is not intended to serve as a compilation of phase diagrams since the scale of the diagrams is too small for accurate quantitative observations. It is intended primarily to reveal systematic relationships. These relationships underlie the various theories of alloy phase stability and can be quite useful in designing new alloys for practical applications.

This chart divides the transition elements into two groups; the dividing line occurs between the column of elements headed by Cr and the column headed by Mn. This is a somewhat natural division. Elements occurring to the left of this line (designated as A-elements) all crystallize in a body-centered cubic structure at some temperature. Elements occurring to the right of the line (designated as B-elements) all crystallize in one of the "close-packed" structures (face-centered cubic or hexagonal).

The chart contains phase diagrams only for those alloy systems involving combinations of an A-element and a B-element. These diagrams are generally more complex and contain a greater variety of intermediate phases than those involving A-A or B-B combinations, which generally form extended terminal solid solutions.

Each diagram is a composite of the best information available in 1979, but there is no guarantee that the source materials are complete, accurate, or reliable. A list of references to the original sources can be obtained from The National Bureau of Standards, Technical Information and Publications Division, Washington, DC 20234. The user is urged to consult these references for quantitative data. Diagrams published for a particular binary system by various investigators can conflict with one another, and a critical review of the published data is virtually indispensable. The three-volume Hansen-Elliott-Shunk series,[1,2,3] while outdated, is an excellent source for critical reviews.

The composition and temperature scales adopted for all of the phase diagrams are shown on the chart with the color code used to identify intermediate phases with selected crystal structures. Phase boundaries are generally drawn as solid lines for clarity, even when these appear as broken lines in the original references. In some cases lines appear which are not given in any of the references. This is done only when there is some reason to believe that such boundaries actually exist as, for example, in the extrapolation of known phase boundaries to lower temperatures.

The chart contains no provision for phase diagrams of technetium since the data for such systems is presently very sparse. Otherwise, the chart is nearly complete. This chart should be helpful to alloy designers and other users of phase diagrams and may stimulate work on the few remaining systems for which not even the most rudimentary outlines of a phase diagram are presently available.

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GENERAL REFERENCES

1 M Hansen and K Anderko, "Constitution of Binary Alloys," 1958, McGraw-Hill, New York, or Business Growth Services, General Electric Co., Schenectady, NY 12345

2 R J. Elliott, ibid, First Supplement

3 F A Shunk, ibid, Second Supplement

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