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DISCUSSION SE RAPPORTANT AUX TROIS COMMUNICATIONS PRÉCÉDENTES

T. B. Massalski (Mellon Institute, Pittsburgh, Pa., U. S. A.) and H. W. King (Imperial College, London, S.W.7, England): The use of atomic volume when discussing size effects in solid solutions permits an interesting comparison between the estimates of atomic size based on the volume per atom Ω and on nearest neighbour distances d, particularly when the solute element has an anisotropic structure, e.g. zinc. The trends in Ω and d for various phases in the Cu-Zn system are shown in figure A. The volume per atom plots deviate towards lower values than those predicted by a straight line drawn between the data for the pure metals, in contrast to the trends in nearest neighbour distances which show a positive deviation labelled + Δd in the figure. Similar conflicting deviations (− ΔV and + Δd) are also observed in the Ag-Zn system, where the solute has a smaller size than the solvent, as shown in figure B. The sign of the ΔV deviation is found to be consistently negative for all the B-subgroup elements when dissolved in copper, silver or gold. On the other hand the sign of the Δd deviation follows no distinct pattern, sometimes being positive as in Cu-Zn and Ag-Zn and sometimes negative as in Ag-Al (fig. B).

Extrapolation of the Ω trends from each individual phase in a binary alloy to 100 % solute enables one to evaluate effective atomic volumes for the solute in each phase, e.g. Ωα, Ωβ, Ωγ, etc... As may be seen in figures A and B, the volume per atom plots in the cubic α, β' and µ phases all fall on a smooth curve and hence all give the same value for the effective atomic volume of the solute. An increase in effective atomic volume is observed on going from the α, β' and µ phases to the complex cubic γ phase and in the h. c. p. α, ε and η phases, the latter effect being associated with various Brillouin zone overlaps. The concept of an effective atomic volume leads to the possibility of expressing the size factors for various solid solutions in terms of volume, i.e. (Ωα − Ω0)/Ω0, where Ωα is the effective atomic volume of the solute in the α phase and Ω0 is the volume pe

Fig. A. — Changes in closest distance of approach, d, and volume per atom in Cu-Zn alloys [1].
atom of the solvent. Taking the strain energy of a solid solution as expressed by the general formula

$$E_s(c) = A\mu\Omega \left( \frac{\Omega}{\Omega_0} \right)^2 \phi(c)$$

where $A$ is a numerical constant, $\mu$ the shear modulus, $\Omega$ the mean atomic volume and $c$ the concentration, it can be shown that provided the atomic volume trends are approximately linear in each phase, the strain energy due to the presence of the solute element is related to the square of the volume size factor as defined above [1].