Diffusion Phenomena Occurring During Sintering

by Ben H. Alexander

THE process of sintering of copper was previously investigated by measuring the change in size and shape of the interstices between fine wires that were closely wound on a spool. These studies are being extended to compacts made from two dissimilar metals. The compacts are made by winding wires of the two metals on a spool at the same time. In such compacts, all possible junctions (A-A, B-B, and A-B) are present although the junctions of dissimilar metals (A-B) are present in the greatest number. The systems being studied are: Ag-Cu, Cu-Ni, Ag-Au, Cu-Fe, Cu-Zn, Ag-Ni, Cu-W, Ag-Zn, and Au-Ni. They were chosen to give a wide range of mutual solubilities and consequently greatly differing amounts of diffusion upon sintering.

After heating the specimens for various periods of time at high temperatures, the progress of sintering and of homogenization are being studied, and dimensional and geometric changes resulting from diffusion are measured.

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It has been found that although a perfectly uniform bond or *neck* is formed between two wires of the same metal, this is not true when the adjacent wires are dissimilar. In the latter case the bond appears to form by the preferential movement of one kind of atom, with the result that the bond or neck is asymmetric, i.e., it is wider on one side than the other. An overall increase in volume of the compacts accompanies this peculiar bond formation, the expansion being greater, the more asymmetric the bond. An attempt is being made to correlate the volume changes, which are considerable in some cases (15 to 20 pct), with the extent of diffusion or homogenization. The present type of specimen should make this correlation easier than with the more familiar *Kirkendall* specimen where the volume changes are greatly restricted.

It has further been found that the rate at which a bond or neck forms between two unlike metals is about equal to the faster of the rates of bond formation between the metals in like pairs.

Age Hardening

by L. F. Mondolfo

AGE hardening in several alloy systems is being investigated at present by hardness and electrolytic potential measurements. X-ray diffraction and resistivity measurements are to be started in the near future. The alloys investigated so far are: AlCu, 4 pct Cu; AlAg, 25 pct Ag; AlCuMg, 4 pct Cu, 1.7 pct Mg; AlZnMg, 6 pct Zn, 2 pct Mg; MgAl, 9 pct Al; and CuBe, 2 pct Be. Other alloys are in preparation.

The results indicate the following tentative conclusions: There are at least two types of age hardening, depending on the complexity of the transformation required to form the lattice of the precipitate from the lattice of the solid solution. A simple transformation, as for example a body centered cubic precipitate forming from a face centered cubic solution, takes place in one step, and only one peak of hardness results. With more complex transformations, at least one intermediate lattice is formed and at least two peaks of hardness result. The first hardening results from the transformation from solid solution to intermediate lattice, and the second hardening from the intermediate lattice to stable precipitate, if there is only one intermediate lattice formed.

Hardening does not result from actual precipitation but from the straining of the lattice caused by segregation and atomic movement prior to the formation of the new phase. Completion of the transformation, by causing a more stable condition, results in softening.

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