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METALLOGRAPHY APPLIED TO MATERIAL SELECTION AND PROCESS DESIGN - A CASE HISTORY

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Technological applications frequently depend for their success on the control of gross features of structure which are readily revealed by even the most elementary forms of optical microscopy. The present discussion is a case in point.

The production of pellets for fountain pen tips involves severe restrictions on the choice of materials and manufacturing processes imposed, in part, by the corrosiveness of inks and the abrasiveness of paper, and in part by the sequence of fabrication operations required to produce a tip-nib assembly. The material must be weldable to the 14 K gold nib alloy; resistant to chipping during slitting, grinding and polishing; and finally, since most of the alloys with the required physical and chemical properties consist of a hard phase imbedded in a softer matrix, must have a microstructure with a fine, uniform dispersion of phases in order to maintain a highly polished surface (desired for smooth writing pens).

These requirements in aggregate eliminate all but alloys of the platinum group metals. The first long lasting pen tips were made from osmiridium, a natural alloy of the platinum metals with a variable composition. Its use, however, entailed a very high incidence of failures and rejects -- thought to be unavoidably related to the hardness and brittleness of osmiridium, and therfore tolerated for many years. The introduction of synthetic alloys with a controlled composition failed to produce any significant improvement. When a metallographic study of the problem was undertaken the defects causing the failures were readily identified as residual cracks and fissures resulting from the crushing operation employed for producing the pellets in granular form.

In order to avoid the use of a crushing operation, spherical pellets, desirable also for automating the welding process, were produced by a shotting technique which, though it required debasing the alloy by additions of tungsten, cobalt and nickel to lower the melting point, did result in a substantial improvement. However, this method, too, gave rise to characteristic defects that were revealed by the microscope: blowholes due to the entrapment of dissolved gases during solidification.

Subsequent research by the author led to the development of a process for imparting to a predominantly powdered metal mass (mainly ruthenium) the properties and fabricating characteristics of a typical thermoplastic material. Essentially, this was accomplished by coating the metal particles with a film of modified polystyrene. It thus became possible to extrude the mixture into thin rod, approximately 1/16 of an inch in diameter, at moderate temperatures in the range 160-175°C. Spheres molded from this thermoplastic rod are heated in accordance with a programmed cycle during the course of which the polystyrene is vaporized and the metal powder is consolidated. This procedure, which requires no addition of base metals, produces pellets that are virtually defect free and which have uniformly fine microstructural features.

From the photomicrographs which are presented a correlation may be seen between the types of defects that are peculiar to certain processes and the characteristic failures they cause during fabrication. Also included are representative microstructures showing the wide range of phase dispersions that are encountered with the various production processes. The coarsest dispersions are found in granular pellets; the finest, in spheres produced from metal powder; while intermediate dispersions are found in spheres produced by shotting.

A more detailed exposition, including the photomicrographs, will be published in the International Journal of Powder Metallurgy, Volume 5, No. 3.

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