CHARACTERISTICS OF METAL POWDERS

The basic characteristics of metal powder have a significant effect on its behaviour during processing, as well as on the properties of the finished product. These basic characteristics are: chemical composition, purity, particle size and distribution of sizes, the shape and micro-structure of the particle and apparent density.

The distribution of particle size is important in packaging the powder and will influence its behaviour during moulding and sintering. In practice, selecting a size distribution for a specific application is based on experience. A finer powder is mainly preferred to a coarser one, since finer metals have smaller pores and larger contact areas, leading to generally improved physical properties after sintering. Distribution of particle size is given in terms of a sieve analysis, i.e. the quantity of powder passing through mesh numbers 100, 200 etc. Obviously, the sieve analysis will return significant results, with the size and distribution of particles only included when they are spherical in shape. If the particles are presented as flakes, incorrect information is obtained.

The size of metal powders can be sub-divided into sieve and sub-sieve intervals. Those belonging to the category of sieve size are generally designated according to the finest mesh that all the powder can pass through. If all the powder passes though a number 200 mesh, it is designated as a powder under number 200, etc. All sub-sieve powders pass through a number 325 mesh used in practice. The size of the powders can be specified by averaging real dimensions found from a microscope examination.

Another important characteristic of the powder is the type of surface on the individual particles. Powders manufactured by chemical reduction of oxides have a very rough surface, while the surface of atomized particles has a much finer roughness rating. The character of the surface will influence the friction forces, which is important when the powder is flowing or deposited during compacting.

Since any reaction between particles or between powder and the surroundings starts on the surface, the amount of surface area per unit of powder can be significant. The surface area is very large for powders made by reduction techniques.

The shape of the particle is important for packaging and powder flow characteristics. Spherical particles have excellent sintering qualities, resulting in an end product with uniform physical characteristics; however, it has been found that irregular-shaped particles are better for practical moulding.

Packaging devices cover three processes: filling spaces between the larger particles with smaller ones, breaking up bridges or arches, and mutual movement and rotation of particles. These processes are important when filling die cavities with metal powder.

The apparent density is the weight of the amount of non-compacted powder needed to completely fill a given mould cavity. Increasing the specific gravity or density of the material increases the apparent density. As said previously, the packaging of powder particles is greatly influenced by the size and shape of the particle. The only way of completely filling a space is to use cubes of the same size and aligned precisely. Any other curved or irregular shaped particles cannot fill a space, and give rise to porosity. The importance of packaging spheres is studied in the theory of crystalline structures, where it is shown that the face-centred cubic and close-packed hexagon structures have high packaging properties. An effective way to increase apparent density is to fill the spaces between particles with smaller particles, which starts a filling array known as interstitial packaging; however, even the smaller particles cannot fill the pores completely. It is even possible that adding smaller particles will reduce the apparent density (opposite to the desired effect) by forming arched cavities.

The apparent density of a powder is a very important property for moulding and sintering operations. Powders with low apparent density require a longer compression cycle and deeper cavities to produce a conglomerate with the given density and size. The tendency of the compressed material to shrink during sintering seems to be less as the apparent density increases.