PAPER NO: 74

RECENT DEVELOPMENTS IN POWDER METALLURGY OF NON-FERROUS METALS (*)

Dr. P. Ramakrishnan,

Department of Metallurgical Engineering
Indian Institute of Technology, Bombay.

The scope of this paper is limited to the developments in powder metallurgy in the field of porous materials, high strength high temperature materials and continuous compaction of metal powders.

Bearings, filters and other porous parts:

Bearings are one of the most important applications of powder metallurgy. The interconnecting pores in these products are filled with oil or other suitable lubricants, which result in self lubrication and reduction in wear during service conditions. Self lubricant bearings and bushings are widely used in electric fans, home appliances, automobiles, office equipments, agricultural equipments, food and textile machinery, fractional horse power electric motors and associated devices. Substantial savings in maintenance costs have been effected by their use. The commonly used non-ferrous metals are copper, lead, tin and recently aluminium. The fatigue strength of bearings can often be improved by bonding the shell of the bearing to a strong support.

Filters are another important use of powder metallurgy parts. They are generally manufactured from spherical powders and less frequently from irregular powders, fibres or a combination of these materials. Some of the manufacturing processes are gravity sintering, pressure sintering, compaction and sintering, slip casting, roll compaction and extrusion. The most commonly used non-ferrous metals for making filters are bronzes, monel, german silver, nickel, tungston, chromium and aluminium. Recently more and more metallic filters are being used.

(*) Paper for presentation at the Symposium on "Recent Developments in Non-Ferrous Metals' Technology"- 4th to 7th December, 1968, Jamshedpur.

Notable among them are zirconium and platinum for high temperature and corrosive applications. Titanium is another newcomer which is replacing stainless steel in aircraft hydraulic systems, largely because of their weight advantage and other favourable properties.

Porous nickel electrodes are another non-ferrous powder metallurgy product, which is gaining its importance. These electrodes are used in alkaline nickel-cadmium batteries and fuel cells.

Porous structures are also used in the distribution and restriction of flow of fluids, in aircraft deicing, heat exchanges and in tranpiration cooling. The use of silver-infiltrated tungsten, produced by powder metallurgy, has considerably reduced the heat transfer to and within the power plant component by transpiration cooling. Porous tungsten structures with controlled porosity are used in cesium-ion engines. Another recent metal powder application is in the development of foamed metal structures of high porosity. Many metals like aluminium, nickel, lead, zinc, copper, tungsten, berylluim etc. have been made into foamed structures. They are produced by treating metal powders with an organic compound in combination with a foaming agent. They are used to absorb impact, deaden noise and vibration or shock and in marine bioyancy devices and in rigid light weight structures.

High temperature materials: Disperson hardened and fibre-reinforced composites.

One of the earliest applications of powder metallurgy is in the fabrication of refractory metals like tungsten. Later the technique has been extended to molydbenum, tantalum, niobium and other high melting point metals and alloys. Now-a-days these materials are widely used for a variety of applications in different sizes and shapes. Recently much attention has been given to the outstanding properties of beryllium for nuclear engineering, aircraft, missile and space craft applications. To attain the required purity and adequate control of grain size the metal has to be processed by the powder metallurgy techniques. The technique has shown considerable economic advantages over melting procedures in terms of greater recovery of a worked product . The marked increase in the working efficiency of a gas turbine, when the operating temperature is increased, has led to the search for better materials.

Many of the Nickel and Cobalt base super alloys are difficult to forge and the casting technique does not allow a close control of structure. To combine the best of features of the two types of materials powder metallurgy techniques have been tried. It is possible to produce super alloys by sintering the pre-alloyed powders.

The search for better materials having greater strength and stiffness at room and at elevated temperatures, coupled with low density has led to the development of a new technique for strengthening by fibre-reinforcement. By incorporating strong stiff refractory fibers it should be feasible to put metals into service, at temperatures much nearer to their melting points than are possible by conventional alloying or by disperson strengthening. These materials can be prepared by the powder metallurgy technique of compaction followed by extrusion, swaging, forging or rolling. In the fibre-reinforced composites it is generally assumed that the relatively soft and ductile matrix acts to transfer load between fibres by shear forces at the interface. The strengthening effect is directly proportional to fibre content, aspect ratio and the orientation of the fibre. Maximum strength is obtained when all the fibres are oriented in the direction stress.

Continuous compaction of metallic powders:

Continuous compaction of metallic powders into semi-finished products such as strips, sheats, tubes, rods and wires is a major break through in powder metallurgy. The process can be used not only for producing speciality items which are not possible by the conventional ways but also for conventional metals like copper, nickel, aluminium, cobalt and so on. Some of the advantages of roll compaction of metal powders are (1) the technique is able to produce thin strips with fewer passes through the mill and fewer annealing cycles than are necessary when commensing with cast billet; (2) the yield is high compared to the ingot to finish strips; (3) superior properties of the powder rolled product in many cases; and (4) high purity of the product. But the major limitation in the wide application of this process was the high cost of the metal powders. In recent years metallic powders became available at lower prices than before and there is a great interest in converting these powders directly into strip. It is now proved that the conversion of metal powder to strip by continuous roll compaction is both practical and economically advantageous.

Recently much interest have been shown for the production of aluminium and nickel coated steel by the continuous roll compaction technique. Pilot plant studies indicate that steel strip can be coated continuously via a nickel slurry process. The powder was applied to the strip in the form of an aqueous slurry which was then dried, sintered, cold, rolled and annealed to give dense adherent coatings of uniform thickness. The coated materials could be deformed and welded with no coating fracture or separation while maintaining good corrosion resistance. Their markets range from automotive and appliances to diary and chemical applications where appearance corrosion resistance and fabricability are essential. Aluminising steel, using aluminium powder became a commercial reality when Elphar Ltd., successfully operated the BISRA's "Elphal" process. Coatings with excellent adhesion and flexibility were produced at reduced cost. Further development by BISRA in the aluminising process led to the dry-powder process. High quality coatings of aluminium upto 0.002 inch thick can be produced on steel strip by this process. Thus there is an incentive to explore further in the field of continuous compaction of metal powders.

PSR/