Production of Metallic Powders:

Many mechanical and chemical methods are used to produce powders for specific applications.

- **<u>Any metal</u> can be made into <u>powder form</u>.**
- **In addition, <u>mechanical methods</u> are occasionally used to <u>reduce powder sizes.</u>**

The most principal methods by which metallic powders are commercially produced

1. **<u>Gas Atomization Method:</u>**

It is the method frequently used for metals having low melting points, such as [tin, lead, zinc, cadmium and aluminum].

- **A liquid metal is forced through a small orifice, and a stream of compressed air causes the metal to disintegrate and solidify into finely divided particles [see fig. (4) below].**

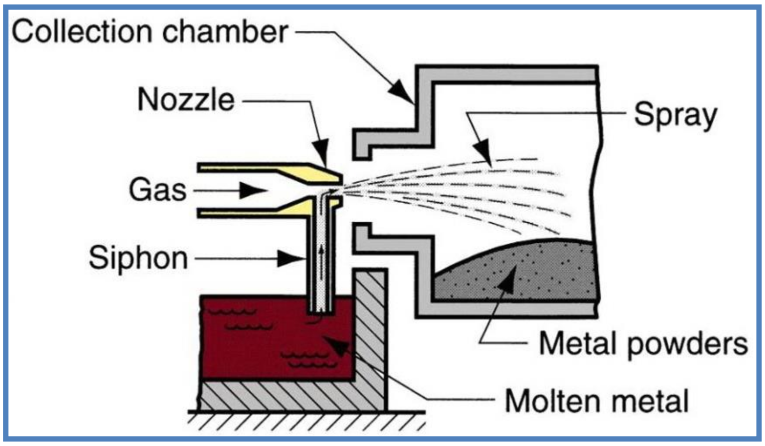

Fig. (4): Gas atomization method.

- **Atomized products are generally in the form of sphere – shaped particles as shown in figure (5) below.**
- **A wide range of particle – size may be obtained by varying the temperature of the metal, pressure of atomizing gas, rate of flow of metal through the orifice and the design of the orifice and nozzle [see fig. (6) below] for other methods of metallic powder production.**

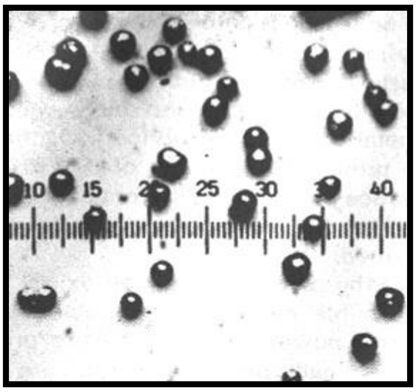

Figure (5): The particles size by atomization method.

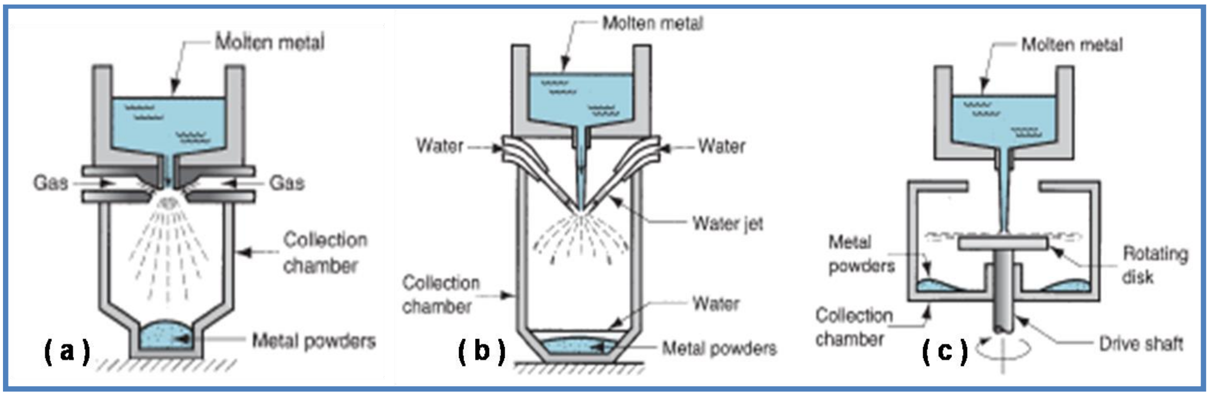

Fig. (6): (a) Other Gas atomization method (b) Water atomization method (c) Centrifugal atomization by rotating disc method.

2. **<u>Machining:</u>**

In this method first chips are produced by filing, turning and subsequently ground by crushing and milling [Figure (7 a)]. The powders produced by this method are coarse in size and irregular in shape.

3. **<u>Crushing and Milling:</u>**

These methods are used for brittle materials (alumina and zirconia powders). Jaw crushers, stamping mills, ball mills are used to breakdown the metals by crushing and impact. [Figure (7 b)].

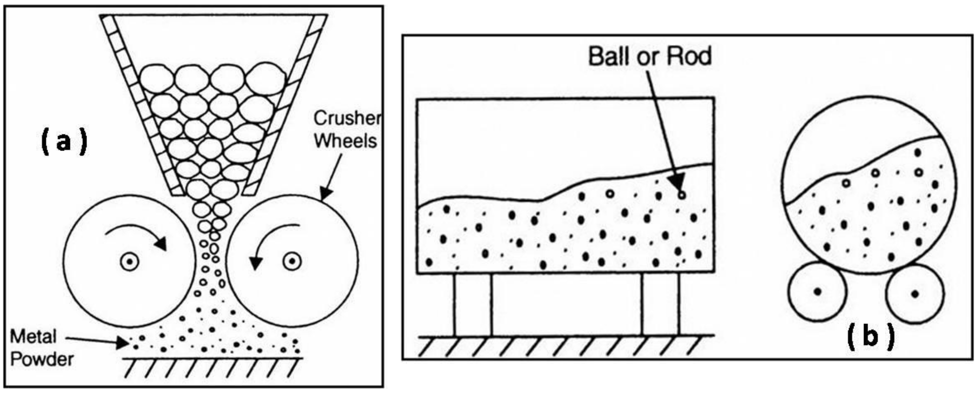

Fig. (7): (a) Crushing & Milling (b) Ball or Rod Milling.

4. **<u>Chemical (Reduction of oxides):</u>**

It is a chemical reaction by which metallic compounds are reduced to *<u>elemental metal powders</u>*.

- **The common process involves liberation of metals from their oxides by use of reduction agents such as *<u>hydrogen (H_2)</u>* or *<u>carbon monoxide (CO)</u>* at an elevated temperature (below the melting point) in a controlled furnace.**
- **The reduction agent is made to combine with oxygen in the compound to *<u>free the metallic element.</u>***
- **This method is used to produce powders of [iron, tungsten and copper].**
- **The particles produced by oxide reduction are *<u>spongelike</u>* in structure and are *<u>ideal for molding</u>* [figure (8) below].**

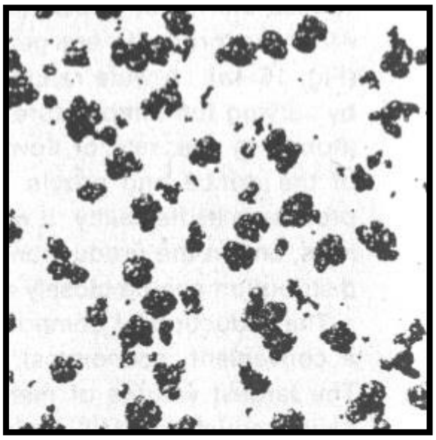

Figure (8): The particles size by Reduction of oxides method.

5. **Electrolytic deposition:**

An electrolytic cell is constructed in which the source of *desired metal is the anode*. The anode is slowly dissolved under an *applied voltage* transported through the *electrolyte*, and *deposited on the cathode*.

- **The deposit is removed, washed and dried to yield a *metallic powder* of very *high purity*. The cost of manufacturing is high.**
- **The technique is used for producing powders of [beryllium, copper, iron, silver tantalum and titanium].**
- **The deposit may be a *soft spongy* substance which is subsequently *ground* to powder.**
- **The shape of electrolytic powder is generally *dendritic* as shown in figure (9).**

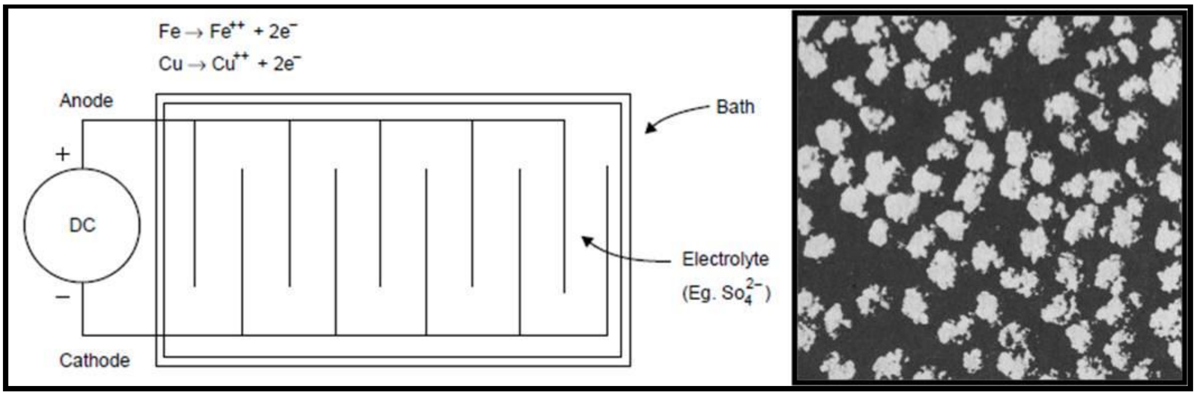

Figure (9): Electrolytic Cell & the particles size by Electrolyte deposition method.

Particle Shapes & Size in PM:

Particle shape is important in influencing the packing and flow characteristics of powders. Spherical – shaped particles have excellent sintering qualities and result in uniform characteristics of the products [see fig. (10) for some powder particle shapes].

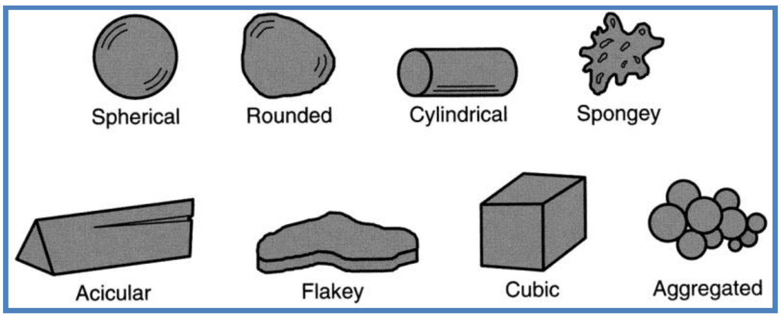

Figure (10): Several of the possible (ideal) particle shapes in powder metallurgy.

Particle – size distribution is important in the packing of the powder. In general, ***a finer powder is preferred over a coarser powder since finer have <u>smaller pore</u> size and <u>larger contact areas</u> which results in better properties after sintering.***