

Tungsten Wire Manufacturing Process

Making tungsten wire is a complex, difficult process. The process must be tightly controlled in order to insure the proper chemistry as well as the proper physical properties of the finished wire. Cutting corners early in the process to reduce wire prices can result in poor performance of the finished product.

Refining tungsten from ore cannot be performed by traditional smelting since tungsten has the highest melting point of any metal. Tungsten is extracted from ore through a series of chemical reactions. The exact process varies by manufacturer and ore composition, but ores are crushed then roasted and/or sent through a variety of chemical reactions, precipitations, and washings to obtain ammonium paratungstate (APT). APT can be sold commercially or further processed to tungsten oxide. Tungsten oxide can be roasted in a hydrogen atmosphere to create pure tungsten powder with water as a by-product. Tungsten powder is the starting point for tungsten mill products, including wire.

Then make pure tungsten powder into tungsten wire through following processes.

1. Pressing - Tungsten powder is sifted and mixed. A binder may be added. A fixed amount is weighed and loaded into a steel mold which is loaded into a press. The powder is compacted into a cohesive, yet fragile bar. The mold is taken apart and the bar removed.
2. Presintering - The fragile bar is placed into a refractory metal boat and loaded into a furnace with a hydrogen atmosphere. The high temperature begins to consolidate the material together. Material is about 60% - 70% of full density, with little or no grain growth.
3. Full Sintering - Bar is loaded into a special water-cooled treating bottle. Electric current will be passed through the bar. The heat generated by this current will cause the bar to density to about 85% to 95% of full density and to shrink by 15% or so. Additionally, tungsten crystals begin to form within the bar.
4. Swaging - The tungsten bar is now strong, but very brittle at room temperature. It can be made more malleable by raising its temperature to between 1200°C to 1500°C. At this temperature, the bar can be passed through a swager. A swager is a device which reduces the diameter of a rod by passing it through a die which is designed to hammer the rod at about 10,000 blows per minute. Typically a swager will reduce the diameter about 12% per pass. Swaging elongates the crystals, creating a fibrous structure. Although this is desirable in the finished product for ductility and strength, at this point the rod must be stress-relieved by reheating. Swaging continues until rod is between .25 and .10 inches.
5. Drawing - Swaged wire of about .10 inches can now be drawn through dies to reduce the diameter. Wire is lubricated and drawn through dies of tungsten carbide or diamond. The exact reductions in diameter depend on the exact chemistry and the final use of the wire. As wire is drawn, fibers again elongate and tensile strength increases. At certain stages it may be necessary to anneal the wire to allow further processing. Wire can be drawn as fine as .0005 inches in diameter.