Co-rolling of tungsten wire at ambient temperature

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Abstract

Tungsten is the most refractory metal in the body centered cubic (BCC) family with a melting point of 3422°C and a high density, about 19.25 g/cm^3. It is a hard metal, used as a thin wire in light bulbs and in engineering for substrates in high power electronics, for electronic tube amplifiers… But tungsten is brittle and difficult to work at ambient temperature; it is usually worked by forging, extrusion or stretching [1].

The ductile-brittle transition temperature (DBTT) allows determining the temperature from which the metal can be rolled. However, heating the tungsten wire above the DBTT to improve the ductility during the process requires reducing atmospheres to avoid oxidation.
At low temperature, the surface presents cracks and notches in areas where, shear or tensile stresses dominate in the contact with cylinders during rolling. One solution considered in our study is to protect the tungsten wire with a ductile cladding to maximize a compressive stress state on the tungsten core. Indeed, copper and/or nickel claddings by electrodeposition on the wire appear to have minimized the effect of surface imperfections after rolling [2] at ambient temperature.

[1] Q. Wei, L.J. Kecskes. Effect of low-temperature rolling on the tensile behavior of commercially pure tungsten. Materials Science and Engineering A 491 (2008) 62–69

[2] Gordon K, Watson. Effect of ductile cladding on the bend transition temperature of wrought tungsten. National Aeronautics and Space Administration, Washington D.C., October 1967

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