多孔钨材料及零件的研究进展 *

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摘　　要:多孔金属材料是一类具有优异性能的新型材料。本文首先简述了多孔金属材料的几种常用制备方法及应用领域。然后对多孔钨材料在微波真空器件、核聚变及空间电推进技术等领域的应用进行了介绍,指出了多孔钨材料及零件制备中存在的问题,针对这些问题对多孔钨材料及零件制备工艺进行了深入研究。利用射流分级技术对钨粉进行了分级,激光粒径测试仪的分析结果表明,分级后的钨粉颗粒度分布更加集中。采用气体纯化装置对烧结用氢气中残余的水和氧进行了净化,使氢气的露点从纯化前的-50℃降到纯化后的-90℃以下,为制备出无氧化的多孔钨材料及零件提供了很好的烧结环境。利用冷等静压技术和高温烧结技术制备出多孔钨材料,压汞仪分析表明钨粉分级使多孔钨材料的比表面积增大,闭孔率大大降低,孔度更加均匀一致。采用真空浸铜的方法制备出多孔钨铜合金材料,与传统氢气浸铜方法相比,真空浸铜的浸渍率提高了4%以上。采用真空去铜法净化了多孔钨铜零件,结果表明该方法具有处理时间短、去铜彻底、对环境无污染等优点。

关　键　词:多孔金属材料;多孔钨;电推进技术;真空浸渍;真空蒸发

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Research Progress of the Porous Tungsten Materials and Parts

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Abstract: The porous metal materials are a new type of metal materials with excellent properties. This review briefly describes the preparation methods and applicability of several commonly used porous metal materials.Then the application of porous tungsten materials in the fields of microwave vacuum devices and space electric propulsion technology is introduced, and the existing problems in the preparation of porous tungsten materials are pointed out. In response to these problems, the preparation process of porous tungsten materials and parts is studied in depth. The tungsten powder is classified by the classification technology. The results of the laser particle size tester show that the size of classified tungsten powder particles is more concentrated. The gas purification and detection system can remove residual oxygen and water in the hydrogen gas, and reduce the dew point of hydrogen from -50℃ to below -90℃, which provides a good sintering atmosphere for preparing the non-oxidized tungsten sponge matrix. Porous tungsten materials are prepared by cold isostatic pressing technology and high temperature sintering, and the porosity of porous tungsten materials is studied by mercury porosimeter. The pore size distribution becomes narrower and the pore size becomes more uniform. The porous tungsten-copper alloy materials are prepared by vacuum impregnation. The impregnation rate is much higher than that of copper impregnation under the hydrogen condition, and the impregnation rate is increased by more than 4%. The tungsten copper alloy substrate is heated by a high frequency heating coil crucible localized firing. The results show that this technology has the advantages of no residual on substrate surface, short time, no pollution to furnaces and environmental. The porous tungsten have been successfully used in the microwave vacuum electron devices.

Key words: porous metal material; porous tungsten; electric propulsion; vacuum impregnation; vacuum evaporation

近年来,多孔金属材料迅速发展成为一种具有功能和结构双重属性的新型工程材料,其由金属基体与孔隙共同组成。多孔金属材料以孔洞连通性划分,可分为开孔金属和闭孔金属两类;以

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