High-Purity Spherical Tantalum Powder for Additive Manufacturing

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Abstract

New developments and innovations in the energy, defense, and medical sectors require advanced materials to meet emerging applications. Refractory metals, such as tantalum and tantalum alloys, are playing a pivotal role in meeting these new challenges due to their high-temperature performance, biocompatibility, and ductility. To achieve the highest performance possible, purity and quality must be maintained from raw material to the final product. Through careful manufacturing controls, high-purity materials can be consistently produced to ensure success in the product applications**.** Additive manufacturing reduces material scrap and waste; therefore lowering the cost and barrier of entry for these alloys, improving the buy-to-fly ratio for many aerospace applications. This presentation will review and highlight high-purity powders developed for a variety of additive manufacturing (AM) techniques such as laser or electron beam powder bed fusion (LPBF, EB-PBF) and directed energy deposition (DED). By controlling impurities such as oxygen, nitrogen, and carbon, it is possible for AM-grade tantalum to achieve mechanical performance on par with wrought materials.

Introduction

Tantalum (Ta) is a dense and ductile refractory metal used in applications which require its thermal performance, chemical resistance, or bio-compatibility [1, 2]. Additive manufacturing lowers the cost of utilization for refractory metals by minimizing material waste and machining time. It allows the creation of novel components in a wide-range of applications that can capitalize on the material properties of tantalum and its alloys, particularly in aerospace and medical. The applications in these industries are exacting, and to achieve the desired performance from printed components the consistency and purity of the powder is paramount. Oxygen and nitrogen act as interstitial elements in tantalum impacting the ductility and mechanical properties of the final material; therefore, it is important to monitor, limit and control these elements during powder manufacture. In addition to the elemental concerns, particle size distribution (PSD), particle shape, powder flow, powder packing, and cleanliness will all have an impact on part and material quality. Achieving and maintaining high quality and high purity material is challenging and it requires careful considerations and engineering controls for every operation from ore refinement to powder storage.