真空雾化制粉技术研究进展及展望

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摘　　要:真空雾化制粉设备作为工业化生产金属粉末的主要设备,广泛应用于增材制造、粉末冶金、航天和医疗等重点领域。本文围绕目前最常见的几种真空雾化制粉技术,对其特点和发展方向进行了深入的研究和探讨。首先简要介绍了雾化制粉的技术背景和当前制粉手段的常见分类,然后结合目前主要的雾化制粉设备制造商和金属粉末供应商所采用的技术及设备的核心性能指标,详细介绍了 VIGA(vacuum induction-melting gas atomization)、EIGA(electrode induction-melting inert gas atomization)、VIGA-CC(water-cooled copper crucible vacuum induction-melting gas atomizing)和 PREP(plasma rotating electrode-comminuting process)方法,并对雾化制粉技术及设备未来的发展方向进行了展望。

关 键 词:雾化制粉;粉末冶金;增材制造

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Research and Development Prospect of Vacuum Atomization Powdering Technology

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Abstract: As the main equipment for the industrial production of metal powder, vacuum atomization milling equipment is widely used in key areas including additive manufacturing, powder metallurgy, aerospace and medical treatment. This paper focuses on the most common vacuum atomization milling technology, and their characteristics and development directions are deeply studied and discussed. Firstly, the technical background of atomized milling and the common classification of current milling methods are briefly introduced, and then combined with the core performance indicators of the technology and equipment used by the major atomization milling equipment manufacturers and metal powder suppliers, the vacuum atomization milling methods including VIGA (vacuum induction-melting gas atomization), EIGA (electrode induction-melting inert gas atomization), VIGA-CC (water-cooled copper crucible vacuum induction-melting gas atomizing) and PREP (plasma rotating electrode-comminuting process) are described in detail. The future development direction of atomization milling technology and equipment is also prospected.

Key words: atomization powder; powder metallurgy; additive manufacturing

随着选择性激光熔化(Selective Laser Melting,SLM)、粉末冶金、弥散强化等技术的发展,高性能金属粉末的需求量日益增加。雾化制粉技术是多种真空熔炼手段与雾化过程的耦合,可以根据客户的工艺需求制备特定颗粒度范围的金属粉末[1]。这些金属粉末经过真空热压成型、热等静压成型、等温锻造、喷射沉积及电火花烧结等技术处理后,可用于制造航空发动机涡轮盘、硬质合金刀具、耐磨刹车盘等涉及多行业的产品。开发具有自主知识产权的粉末材料制备技术和设备,对于促进我国增材制造和粉末冶金技术在航空航天等领域的应用具有重要意义。本文综述了目前最常见的几种真空雾化制粉技术,对其设备特点进行了深入的研究和探讨,介绍了主要的雾化制粉设备制造商和金属粉末供应商所采用的技术及设备的核心性能指标,并对雾化制粉技术的未来发展方向进行了展望。

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