磁粒复合研磨 SUS304 不锈钢孔道的机理与试验研究

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摘 要：目的 为探究磁粒研磨法对 SUS304 不锈钢孔道表面质量的影响，优化磁粒研磨工件内表面的工艺方案。**方法** 首先，基于磁极单轨迹运动和复合轨迹运动两种不同形式，分别对磁粒研磨孔道内表面的基本原理和运动轨迹进行了理论分析；其次，利用 ANSYS 软件对孔道内壁的磁场强度进行了有限元分析；最后，通过磁粒研磨法对孔道内壁进行试验验证。利用超景深 3D 显微镜和触针式表面粗糙度测量仪，分别测取孔道表面微观形貌和表面粗糙度。**结果** 研磨加工时间均为 15 min，磁极为单轨迹运动时，工件表面材料去除量为 662 mg，孔道内壁的表面粗糙度值由原始的 2.0 μm 降至 0.48 μm；磁极为复合轨迹运动时，工件表面材料去除量高达 892 mg，孔道内壁的粗糙度值下降至 0.24 μm。**结论** 磁极为复合轨迹运动时，相对于传统的磁极单轨迹运动，磁粒研磨效率进一步提高，工件表面微观形貌以及表面粗糙度都有明显改善，研磨后的工件内表面质量更佳。

关键词：磁粒研磨；SUS304 不锈钢孔道；复合轨迹运动；材料去除量；粗糙度；表面形貌

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Mechanism and Experimental Study of SUS304 Stainless Steel Hole by Magnetic Particle Compound Grinding

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ABSTRACT: The work aims to study the influence of magnetic particles finishing on the hole surface quality of SUS304 stainless steel and optimize the process program for grinding the workpiece inner surface by magnetic particle. Firstly, based on single trajectory motion and compound trajectory motion of magnetic pole, the basic principle and motion trajectory of grinding the hole inner surface by magnetic particle were analyzed theoretically. Secondly, the magnetic field strength of the hole inner wall was analyzed for finite element by ANSYS software. Finally, the verification test was conducted by using magnetic particle to grind the inner surface of the hole. The topography and roughness of the hole surface were measured by the ultra depth 3D microscope and the stylus surface roughness meter. When the situation of magnetic pole was single trajectory motion, the process time was 15 min. When the material removal amount of the workpiece was about 662 mg, the surface roughness of the inner surface of the hole was reduced to *Ra* 0.48 μm from

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