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磁力研磨法对陶瓷管内表面超精密抛光技术的试验研究

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摘 要: 应用磁力研磨法,利用外部磁场控制陶瓷管内部的磁粒刷运动,从而实现对整个陶瓷管内表面的超精密抛光. 通过理论分析和试验结果相结合的方法验证了应用磁力研磨法对陶瓷管内表面进行光整加工方法的可行性; 为了提高研磨效率,利用 ANSYS 软件模拟分析并结合试验验证,提出了在陶瓷管内部增加 V 型磁铁,改变磁回路的磁力线分布,增大了工作区域的磁感应强度,研磨效率成倍增加; 通过试验分别对研磨液用量、铁粒子粒径、金刚石粒子粒径等参数对陶瓷管内表面研磨质量和效率的影响进行分析和研究,对工艺参数进行了优化设计. 试验结果证明磁力研磨后陶瓷管内表面粗糙度值 R_a 可以由原始的 0.4 μm 降至 0.02 μm,达到镜面抛光的效果,为陶瓷管内表面超精密抛光加工提供了一种新方法.

关键词: 陶瓷管; 磁力研磨; 混合磨料; V 型磁铁
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Experimental Investigation of Magnetic Abrasive Finishing for Super Precision Polishing of Inner Surface of the Ceramic Tube

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Abstract: Super polishing of the inner surface of the whole ceramic tube was achieved by applying magnetic abrasive finishing (MAF) and utilizing an external magnetic field controlling the magnetic particles brush movement inside the ceramic tube. By combining the theoretical analysis with experimental results, the feasibility that applying MAF to polish inner surface of the ceramic tube was verified. In order to improve grinding efficiency, using software simulation analysis and experimental verification, adding the V - shaped magnet into the ceramic tube was proposed. This changed lines of magnetic force distribution of the magnetic circuit and increased the magnetic flux density of the work area, and grinding efficiency can be doubled. Through the experiments, the effects of the amount of slurry, iron particle size, diamond particle size and other parameters on the quality and efficiency of the grinding the inner surface of the ceramic tube were analyzed. The process parameters were optimized design. The test results proved that surface roughness R_a values of inner of the ceramic tube after MAF can be reduced from 0.40 μm to 0.02 μm, which was a mirror polishing. This method provided a new approach for ultra - precision polishing the inner surface of ceramic tube.

Key words: ceramic tube, magnetic abrasive finishing, mixed abrasive, V - shaped magnet

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