石英玻璃管内表面的复合光整试验研究

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摘 要：目的 探究超声磁粒复合研磨与超声振动复合抛光两个试验阶段对石英玻璃管内表面加工的可能性，寻求最优的工艺参数组合。**方法** 在石英玻璃管内添加柱形径向充磁辅助磁极，并添加超声振动，组成复合光整装置。在辅助磁极表面包裹一层研磨粒子，构成超声磁粒研磨装置，在辅助磁极外表面包裹一层聚氨酯，构成超声振动抛光装置。**结果** 对上述的超声磁粒复合研磨阶段进行响应面优化，在主轴转速、振动频率、粒径三个变量中，保持其中一个变量不变，另外两个变量组合，使表面粗糙度值达到最低。选用最优的工艺参数组合作为第一阶段主要参数，经 40 min 研磨，表面粗糙度值从原始的 4.40 μm 下降到 0.19 μm。在第一阶段基础上进行第二阶段抛光，经 5 min 抛光，表面粗糙度值从 0.19 μm 进一步下降到 0.07 μm。**结论** 通过响应面优化得到最优超声磁粒复合研磨组合为：主轴转速 1000 r/min、粒径 250 μm、振动频率 20 kHz。经超声磁粒复合研磨与超声振动复合抛光两个阶段加工后，玻璃管内表面存在的凹坑、突起及划痕均得到有效去除，表面更加均匀、平整。

关键词：超声磁粒复合研磨；超声振动复合抛光；响应面法；石英玻璃管；表面粗糙度值；表面形貌

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Experimental Study of Composite Finishing on the Inner Surface of Quartz Glass Tube

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ABSTRACT: The work aims to explore the possibility to process the inner surface of the quartz glass tube in two experimental stages of ultrasonic magnetic particle composite grinding and ultrasonic vibration compound polishing to obtain the optimum combination of process parameters. A cylindrical radial magnetizing auxiliary pole was added in the quartz glass tube and ultrasonic vibration was added to form a composite finishing device. An ultrasonic magnetic particle lapping device was formed by wrapping a layer of abrasive particles on the auxiliary magnetic pole surface, and an ultrasonic vibration polishing device was formed by wrapping a layer of polyurethane on the outer surface of the auxiliary magnetic pole. The response surface was optimized in the above mentioned ultrasonic magnetic particle complex grinding stage. Among the three variables of spindle speed, vibration frequency and particle diameter, one of the variables was kept unchanged, and the other two variables were combined

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