doi: 10.11933/j.issn.1007–9289.2016.03.017

钛合金管内表面的电化学磁力研磨复合光整试验*

廖 明，韩 冰，陈 燕，喻正好
(辽宁科技大学 机械工程与自动化学院，辽宁 鞍山 114051)

摘 要: 针对热挤压成型对钛合金管的内表面会产生微裂纹、褶皱、毛刺等表面缺陷的问题，提出了一种高效率的电化学磁力研磨复合光整加工方法。设计了电化学磁力研磨复合光整加工的实验装置，分别与纯磁力研磨加工和纯电化学加工进行了光整加工试验对比，检测分析了不同工艺加工前后表面的粗糙度、微观形貌、摩擦磨损行为、表面残余应力和能量谱。结果表明：在相同的加工时间内，与单纯电化学加工和磁力研磨加工相比，电化学磁力研磨复合光整加工的表面粗糙度 *Ra* 可达到0.2 μm，材料去除量和加工效率显著提高；表面显微形貌要明显优于其他两种加工方式；且加工后表面很好地维持了原有材料的化学成分和表面性质；能够使表面由拉应力转变为约–200 MPa的压应力状态，从而获得更好的表面应力状态。

关键词: 钛合金；电化学；磁力研磨；光整加工；残余应力
中图分类号: TG176 **文献标识码:** A **文章编号:** 1007–9289(2016)03–0123–09

Inner Surface of Titanium Alloy Tube by Eletrochemical Magnetic Abrasive Compound Finishing

LIAO Ming, HAN Bing, CHEN Yan, YU Zheng-hao
(School of Mechanical Engineering and Automation, University of Science and Technology Liaoning, Anshan 114051, Liaoning)

Abstract: In view of the problem that hot extrusion of titanium alloy tube inner face cannot meet the use requirements, an electrochemical magnetic abrasive finishing method was proposed. Compared with magnetic abrasive finishing and electrochemical finishing, surface roughness, surface topography, friction wear behavior, X-ray diffraction of surface residual stress and surface energy spectrum were observed and detected. The processing effects and causes of the three processing methods were analyzed. The results show that compared with electrochemical finishing (EF) and magnetic abrasive finishing (MAF), electrochemical magnetic abrasive compound finishing machining (EMACFM) can obtain better surface roughness, material removal rate, and surface topography in the same processing time. The material removal way of compound finishing and simple magnetic abrasive finishing is obviously different. The material surface property is well maintained after the composite finishing. The composite process can make the surface change from tensile stress to compressive stress on the surface to achieve better surface stress state, which illustrates the feasibility and effectiveness of the processing.

Keywords: titanium alloy; electrochemical; magnetic abrasive finishing; finishing machining; residual stress

0 引 言

随着先进制造技术和科学生产力的高速发展，机械零件的使用性能越来越受到人们的重视，表面完整性是衡量机械零件表面质量的技术指标，对零件使用性能有重要影响[1]。钛合金管因其具有耐高压、耐腐蚀等特性，广泛应用在军工、海洋、石油化工等领域，主要用于制造枪炮管、深潜

收稿日期：2015-11-02；**修回日期**：2016-04-21；**基金项目**：*国家自然科学基金(51105187)

通讯作者：陈燕(1963—)，女(汉)，教授，博士；**研究方向**：精密加工技术；**Tel**：(0412) 5928 113；**E-mail**：laochen412@gmail.com

网络出版日期：2016-06-20 09:02；**网络出版地址**：http://www.cnki.net/kcms/detail/11.3905.TG.20160620.0902.002.html
引文格式：廖明, 韩冰, 陈燕. 等. 钛合金管内表面的电化学磁力研磨复合光整试验[J]. 中国表面工程, 2016, 29(3): 123-131. LIAO M, HAN B, CHEN Y, et al. Inner surface of titanium alloy tube by eletrochemical magnetic abrasive compound finishing[J]. China Surface Engineering, 2016, 29(3): 123-131.