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脉冲激光抛光 Cr12MoV 表面改性研究

刘泽辉[1]，米高阳[1]，王春明[1,*]

[1]华中科技大学材料科学与工程学院，湖北武汉，430074

*Email: d202080354@hust.edu.cn

摘要：为提高模具的表面光洁度和尺寸精度，表面抛光技术成为模具加工过程中的一项必要技术。传统抛光手段存在效率低下、工作环境差等局限性，不满足高效高精度的生产需求。因此，亟需一种新的抛光技术来代替传统的模具抛光技术。激光抛光技术就是解决该问题的方法之一。值得注意的是，抛光过程中可能存在的氧化膜变化，现有研究中对与激光抛光模具钢的阈值讨论较少，对于硬度等关键形的变化也缺乏深入研究。采用500W纳秒脉冲激光器对Cr12MoV模具钢进行抛光。对于线切割表面和机械打磨表面两种不同的状态，分别研究了初始表面状态不同导致的激光抛光后表面形貌的差异。对于线切割表面，研究了激光抛光Cr12MoV的能量密度阈值和连续熔化条件，Cr12MoV的抛光阈值为2.5J/cm^2，连续熔化条件为光斑搭接率96%。Cr12MoV线切割表面的污染物及氧化膜会对抛光的效果产生影响，XPS和EDS结果显示激光抛光后表面的成分发生了变化。由于熔池流动，Cr的氧化物残留在材料中。激光抛光产生了重熔层，影响了Cr12MoV的硬度，激光抛光后表层硬度有所提高。通过EBSD结果分析了激光抛光对组织的影响。对比了400#砂纸机械打磨后的表面和线切割表面激光抛光后的截面组织性能变化，通过EDS分析了截面的元素分布。分别对比了不同初始表面状态下表面的宏观和微观粗糙度，机械打磨后的样品表面粗糙度更低。

关键词：激光抛光；粗糙度；模具钢；氧化膜；表面形貌

Abstract: In order to improve the surface finish and dimensional accuracy of moulds, surface polishing technology has become a necessary technology in the mould processing process. Traditional polishing has limitations such as low efficiency and poor working environment. It does not meet the needs of efficient and high-precision production. Therefore, a new polishing technology is urgently needed to replace the traditional mould polishing technology. Laser polishing technology is one of the solutions to this problem. It is worth noting the possible oxide film changes during the polishing process. The threshold values associated with laser polished mould steels are less discussed in existing studies. There is also a lack of in-depth studies on the variation of key shapes such as hardness. Laser polishing of Cr12MoV mould steel using a 500W nanosecond pulsed laser. Two different states of wire cut surface and mechanically polished surface are discussed in this paper. The differences in surface morphology after laser polishing due to the different initial surface states are investigated. For the wire-cut surface, the energy density threshold and continuous melting conditions for laser polishing of Cr12MoV were investigated. The energy density threshold for laser polishing of Cr12MoV was 2.5 J/cm^2. The suitable spot overlap for continuous melting is 96%. The contaminants and oxide film on the wire-cut surface of Cr12MoV had an effect on the polishing results. The results of XPS and EDS showed that the composition of the surface changed after laser polishing. Oxide of Cr remains in the material due to melt pool flow. Laser polishing produced a remelting layer， and it affected the hardness of Cr12MoV. The hardness of the surface layer increased after laser polishing. The effect of laser polishing on the micro structure was analyzed by means of EBSD results.

The changes in the structural and properties of the cross-section after mechanical polishing with 400# sandpaper and after laser polishing of the wire-cut surface were compared. The elemental distribution of the cross-sections was analysed by EDS. The macroscopic and microscopic roughness of the surfaces were compared for different initial surface states respectively. The mechanically polished samples had lower surface roughness after laser polishing.

Key words: Laser polishing; Roughness; Die steel; Oxide film; Surface topography

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