真空镀膜助力低碳制造与可持续发展 *

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摘 要:真空镀膜是一种在真空环境下制备高性能涂层材料和高质量表面的绿色制造技术。目前广泛应用的物理气相沉积技术制备的硬质涂层系列产品,能够助力制造业实现低碳制造和可持续发展。在真空镀膜实际应用过程中,摩擦学与表面界面是需要重点研究的科学性问题。高端真空镀膜设备的开发需要解决核心零部件、先进镀膜工艺及控制系统等技术难题,特别是要主动融入第四次工业革命的浪潮中,探索数字化变革之路。本文介绍了真空镀膜助力低碳制造和可持续发展的具体路径,除了工模具行业和汽车行业等成熟市场,真空镀膜对医疗行业、航空航天和半导体行业的创新发展亦可提供重要的支撑。

关 键 词:真空镀膜;低碳制造;可持续发展;数字化

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Vacuum Coating Helps Low-carbon Manufacturing and Sustainable Development

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Abstract: Vacuum coating is a green manufacturing technology which can prepare high performance coating material and high quality surface under vacuum environment. At present, the hard coating series products which is majorly prepared by physical vapor deposition technology can help the manufacturing industry to achieve low-carbon manufacturing and sustainable development. In the process of vacuum coating application, tribology and surface interface are important scientific issues, while key technical problems need to be solved for advanced vacuum coating equipment, such as high-end core parts, coating process and control system, in particular to the initiative into the fourth tide of the industrial revolution as well as exploring the road of the digital revolution. This paper introduces the specific path of vacuum coating to help low-carbon manufacturing and sustainable development. In addition to mature markets such as tool industry and automobile industry, vacuum coating can also provide important support for the innovation and development of medical industry, aerospace and semiconductor industry.

Key words: vacuum coating technology; low carbon manufacturing; sustainable development; digitalization

真空镀膜技术是一种在真空状态下制备高质量表面的制造技术。目前应用较多的是物理气相沉积(PVD)技术,包括真空电弧离子镀和磁控溅射等。

近年来,真空镀膜技术(主要是 PVD 技术)取得了很多重要进展和工程应用。通过在腔体中增加弧光放电离子源,能够产生高密度等离子体,显著提高气体的离化率(图 1)。磁控溅射/电弧离子镀复合技术结合了磁控溅射和电弧离子镀的优点:具有更高的离化率;蒸发过程中无液滴,可制备光滑表面;涂层具有极高的密度和硬度;膜基结合力好。电弧离子镀 + 脉冲增强电子发射

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