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激光熔覆 Y_2O_3 掺杂金属陶瓷基纳米复合太阳能选择性吸收涂层

Y_2O_3-doped cermet based single-layer nano-composite solar selective absorbing coating by laser cladding

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摘要：具有宽温域太阳能吸收性的太阳能选择性吸收涂层有助于实现太阳能热系统的高光热转换效率。为此采用激光熔覆技术在不锈钢基体上制备了 TiN/TiC-Ni/Mo-Y_2O_3 金属陶瓷基层单层纳米复合太阳能选择性吸收涂层。通过进行涂层的温度场仿真，试验出激光熔覆的合理工艺参数为 P=1KW、D=3mm、V=3mm/s。通过对仿真和实验结果的对比，证明仿真后的工艺参数是合理的。当 Y_2O_3 的含量为 3wt%时，涂层光学性能达到最佳，吸收率α为 0.9，发射率ε为 0.028，光热转换效率为 0.86。在 800℃下处理 24h 后，涂层的吸收率和发射率分别为 0.81 和 0.029，已是性能优异的单层吸收涂层。同时测试了涂层的表面硬度较基体提高 0.75 倍，达到 364HV。稳态平均摩擦系数是基体的 1.4 倍，耐腐蚀性也大大提高。因此，所开发的金属陶瓷涂层显示出宽温域耐腐蚀和硬质防护功能的低成本镀膜的潜力，并具备太阳能热应用所需的光学性能及热稳定性。

关键词：太阳能吸收涂层；激光熔覆；硬质保护涂层

Abstract： The solar selective absorption coating with wide temperature range solar absorption is helpful to realize the high photothermal conversion efficiency of solar thermal system. Therefore, a single-layer nanocomposite solar selective absorption coating with TiN/TiC-Ni/Mo-Y_2O_3 cermet substrate was prepared on stainless steel substrate by laser cladding technology. Through the simulation of the temperature field of the coating, the reasonable process parameters of laser cladding are P=1kW, D=3mm and V=3mm/s. Through the comparison of simulation and experimental results, it is proved that the process parameters after simulation are reasonable. When the content of Y_2O_3 is 3wt%, the optical properties of the coating are the best, the absorption rate α is 0.9, the emissivity ε is 0.028, and the photothermal conversion efficiency is 0.86. After treatment at 800℃ for 24h, the absorptivity and emissivity of the coating were 0.81 and 0.029, respectively, indicating that the coating was a single-layer absorption coating with excellent performance. Meanwhile, the surface hardness of the coating was 0.75 times higher than that of the substrate, reaching 364HV. The steady state average friction coefficient is 1.4 times of the matrix, and the corrosion resistance is greatly improved. Therefore, the developed cermet coating shows the potential of low cost coating with wide temperature range corrosion resistance and hard protection, and has the optical properties and thermal stability required for solar thermal applications.

Keywords： Solar absorber coating；Laser cladding；Hard protective coating

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