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预热对钨合金表面制备 WC/W2C 单道熔覆层组织的影响

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摘要：钨合金表面制备硬质涂层以提高其性能和使用寿命是钨合金应用的发展趋势。本文通过激光熔覆 WC 粉末，在钨合金表面原位合成 WC/W_2C 复合组织单熔覆道，研究了不同预热条件下熔覆道组织的特征。熔覆层内部主要含有四种物相，C，W，δ-WC 以及 β"-W_2C，随着预热温度的提高，熔覆层内部组织逐渐改变，表现为 C 含量的逐步降低，熔覆层组织由 C，δ-WC，β"-W_2C 向 δ-WC，β"-W_2C 及 W 转变。预热对组织的影响体现在熔池的 W-C 比例随着预热温度的提高逐步减小，且预热后熔覆层从上到下的组织更均匀，熔覆层上下部位碳含量差异逐渐减小，同时随着预热温度逐渐升高，凝固速度降低，温度梯度减小，熔覆层从胞状晶向等轴晶改变。随预热温度增加，组织硬度先增大后减小。在预热温度达到 400 摄氏度时，可有效消除裂纹，获得硬度超过 1400HV 的 δ-WC，β"-W_2C 及 W 的复合组织。该成果为将来钨合金表面无缺陷、高性能硬质涂层的制备提供了一种新的技术。

关键词：激光熔覆；钨合金；预热；WC/W2C复合组织

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Effect of preheating on the microstructure of WC/W_2C single track prepared on the surface of tungsten alloy

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Abstract: Preparation of hard coatings on the surface of tungsten alloy to improve its performance and service life is the development trend of tungsten alloy applications. In this paper, WC/W_2C single track was in-situ produced on the tungsten alloy surface by laser melting deposition of the WC powder, and the characteristics of the microstructure of the track under different preheating conditions were investigated.

The microstructure of the clad layer mainly contains four phases, C, W, δ-WC and β"-W_2C. With the increase of the preheating temperature, the microstructure of the track gradually changed, showing a gradual decrease of the C content, and the microstructure changed from C, δ-WC and β"-W_2C to δ-WC, β"-W_2C and W. The effect of preheating on the microstructure is the fact that the W-C ratio of the melt pool gradually decreased with the increase of preheating temperature, and the microstructure of the track is more uniform from the top to the bottom of the cross-selection after preheating, and the difference of carbon content between the top and bottom parts of the cross-selection gradually decreased. Meanwhile, as the preheating temperature gradually increased, the solidification rate decreased, the temperature gradient decreased, and the microstructure of the track changed from cellular crystal to equiaxed crystal. As the preheating temperature increased, the hardness of the tissue first increased and then decreased. At the preheating temperature of 400 ℃, cracks can be eliminated effectively and composite tissues of δ-WC, β"-W_2C and W with hardness over 1400 HV can be obtained. The results provide a new technique for the preparation of crack-free, high-performance hard coatings on tungsten alloy surfaces in the future.

Keywords： Laser melting deposition; tungsten alloy; Preheating; WC/W_2C composite microstructure