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Characteristics and mechanical properties of thermally sprayed coatings at off-normal spray angles with/without nitrogen gas shielding

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Spray angle is one of key parameters for thermal spray technologies especially crucial for coating components of complex geometry. In this work, the influence of spray angle on the coating microstructure and mechanical properties is investigated for HVOF sprayed WC-10Ni coatings, particularly concerning the WC phase decomposition in both spraying scheme of N_2 and air cooling. A general consistency is observed for both cooling conditions that the WC phase transformation to W_2C and WC_{1-x} is enhanced with decreasing the spray angle from 90° to 30°. Moreover, the WC decomposition in the sprayed coatings can be obviously suppressed by the nitrogen gas shielding, leading to a retention degree of WC phase at the spray angle of 45° comparable to that of coatings deposited at the spray angle of 90° under air cooling. Consequently, a slight enhancement in microhardness is observed, but toughness of coatings is not improved. The morphology and porosity, the microhardness and toughness, and the wear performance of the coatings under different spray angles are compared and discussed along with the phase transformation. Taking into account the effect of spray angle, the higher global porosity of coatings deposited at lower spray angles leads to a certain reduction in the fracture toughness and wear resistance but contribute to a better lubrication condition with smaller friction coefficient especially for the nitrogen gas introduction scheme. It is indicated that the fracture toughness is mainly affected by the cohesion of WC-Ni coatings, and wear behaviors of the coatings are primarily affected by both cohesion and lubrication condition.

Keywords
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Decarburization
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