

Development and Tribological Evaluation of Atmospheric Plasma Sprayed NiCrBSi–Mo Composite Coatings for Garret Coiler and Roll Mill Applications

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Abstract

Garret coiler and hot-strip roll mill components operate under severe combinations of elevated temperature, sliding contact, and abrasive oxide-scale interaction, which together limit their service life and increase maintenance costs in steel processing plants. This work investigates atmospheric plasma sprayed (APS) NiCrBSi coatings modified with molybdenum (Mo) as a candidate solution to this problem. Three duplex coating systems, each with a NiCr bond coat and a NiCrBSi top coat containing 0, 10, and 20 wt.% Mo (designated C0, C1, and C2), were deposited on AISI 4140 steel substrates. Feedstock powders were characterised by scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), and X-ray diffraction (XRD) prior to deposition. Coating hardness was evaluated by Vickers microindentation, and tribological performance was assessed using a pin-on-disc tribometer under dry sliding at loads of 10–30 N and temperatures of 100–300 °C in accordance with ASTM G99. Results show that Mo addition reduced hardness only moderately (1045 HV for C0 to 985 HV for C1 and 970 HV for C2) while producing a substantial, compositiondependent improvement in wear resistance. Averaged across all test conditions, mean wear depth decreased from 455 µm for C0 to 137 µm for C1 (a 70% reduction) and 339 µm for C2, with C0 alone exhibiting catastrophic wear at combined high load and high temperature. The improvement is attributed to formation of a lubricious MoO₂ tribofilm that becomes progressively more protective above approximately 200 °C. The 10 wt.% Mo coating offered the most stable performance across the full test window and is recommended for Garret coiler surfaces and general roll mill duty, while the 20 wt.% Mo coating is proposed as an alternative for roll positions operating continuously at sustained high temperature.

Index Terms

NiCrBSi, Molybdenum, Atmospheric Plasma Spray, Tribology, Pin-On-Disc, Wear Resistance, Tribofilm, Garret Coiler, Roll Mill, Coating