HÖGSKOLAN VÄST

Towards more sustainable approaches for protecting surfaces against wear

KAVEH TORKASHVAND

AKADEMISK AVHANDLING

som med tillstånd av Forsknings- och utbildningsnämnden
vid Högskolan Väst, för avläggande av doktorsexamen i produktionsteknik,
framläggs för offentlig granskning.

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Opponent: Professor Nuria Espallargas, NTNU

Abstract

Title: **Towards more sustainable approaches for protecting surfaces against wear**

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WC-Co coatings, with and without chromium additives, are widely used in the industry for severe tribological applications. However, concerns about cobalt supply and its environmental and health impacts have led industries to explore sustainable binder alternatives. As a deposition technique, high velocity air-fuel (HVAF) spraying technology offers a promising solution by producing dense WC-based coatings with minimal material degradation during spraying. Moreover, the combination of high velocity and low flame temperature in HVAF enables the deposition of finer powders, which are more susceptible to thermal damage, with minimal decarburization. This results in denser coatings with improved properties compared to conventional spraying techniques. Therefore, this thesis aims to evaluate more sustainable approaches to depositing WC-based wear-resistant coatings involving (a) HVAF as a less energy-intensive technique compared to other methods like high velocity oxy-fuel (HVOF), (b) alternative Co-lean/free binders, and (c) fabrication of thin ('flash') coatings from finer feedstock powders.

Characteristics and tribological behaviour of HVAF-sprayed WC-CoCr coatings were investigated by spraying feedstock powders with varying particle sizes (ultra fine: 15/5, fine: 20/5, medium: 30/5 and coarse: 45/5 μm) employing different nozzle configurations (various lengths and divergence-convergence configurations). Additionally, different WC-based feedstocks, comprising alternative binders to traditionally used CoCr (namely NiMoCrFeCo, FeNiCrMoCu and FeCrAl) were investigated. Results showed that the HVAF spraying excelled in processing WC-based powders with various size distributions, enabling the deposition of thinner coatings from "ultra fine" powders ('flash' coatings) with similar properties/performance as thick coatings. This leads to reduced material usage while offering potential for considerable component life extension, both of which are important elements of sustainability. Additionally, it was concluded that the Co-lean/Co-free binders demonstrated comparable, and in some cases superior performance than the reference Co-based binder under various wear conditions. All of these together can represent a significant step forward towards more sustainable approaches for protecting surfaces against wear.