



Microstructural characteristics and wear behaviour of HVOF sprayed Ni-SiC composite coatings

Tunji Adetayo Owoseni ^{a,*}, Lidia Baiamonte ^b, Timothy Dumm ^c, Stefan Björklund ^a, Shrikant Joshi ^a

^a University West, Trollhättan, Sweden

^b ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Frascati Research Center, Via Enrico Fermi, 45, Frascati, I-00044, Italy

^c Hyperion Materials & Technologies, 6325 Huntley Road, Worthington, OH, 43085, United States

ARTICLE INFO

Handling Editor: Dr P. Vincenzini

Keywords:

Silicon carbide
Composite coatings
HVOF
Wear
Microstructure

ABSTRACT

High-velocity air fuel (HVOF)-sprayed SiC coatings have been investigated as a potential approach to address challenges associated with their successful application through thermal spraying, since SiC can potentially serve as a sustainable replacement for WC in tribological hard coatings. Ni-P capped SiC feedstock was processed to fabricate composite coatings using HVOF, which is a relatively recent versatile and cost-effective spray technique. Three coatings, Ni-SiC-1, Ni-SiC-2, and Ni-SiC-3 were sprayed using various parameters to investigate the relationship between the processing conditions, microstructure, and wear performance. The extent of SiC retained in each of the coatings, albeit fragmented, was determined to be ~25 % for each of the three coatings compared to the 54 wt % SiC presence in the feedstock. However, despite the similarity in the quantity of SiC retained in the respective coatings, two of the coatings (Ni-SiC-1 and Ni-SiC-2) showed mixed amorphous and crystalline phases, whereas the Ni-SiC-3 coating was fully crystalline. The microindentation hardness of the coatings in the as-sprayed and annealed forms was noted to be in the range of 800–850 HV0.1. The specific wear rates for the respective coatings in the as-sprayed and annealed forms were found to be promising but of the same order of magnitude, revealing no significant role of annealing on their tribological behaviour. The results establish that it is possible to process a suitably designed SiC feedstock using HVOF to realize a sustainable wear-resistant coating.

1. Introduction

Wear is a critical life-limiting phenomenon that governs the performance and sustainability of many engineering components and installations. The resulting losses due to wear of components have both economic and environmental impacts [1]. In addition to lubrication, coating engineering components with hard materials is a common approach for mitigating the impact of wear. Tungsten carbide (WC) has been used in coatings for protection against wear in the industry for decades, owing to its outstanding tribological performance when incorporated into binder materials such as Co [2,3]. However, both W and Co have been listed by the European Commission as critical raw materials for potential risks concerning unhindered and reliable access to them as well as attendant economic implications [4]. In this regard,

alternate hard materials have been explored as potential tribological coatings notably: diamond [5], cubic boron nitride (cBN) [6], titanium carbide (TiC) [7–9] chromium carbide (Cr₃C₂) [10] and silicon carbide (SiC) [11–13]. SiC is favoured among these alternatives for sustainability reasons in addition to its unique engineering properties. SiC can be produced from starting materials involving non-strategic sources that are in abundant supply, such as rice husk [14] and bamboo leaves [15]. The main engineering properties of SiC relevant to dry sliding wear protection applications are its hardness (~30 GPa) [16] and low coefficient of friction (0.2–0.3).

SiC is highly attractive as a coating material, particularly because of its tribological characteristics such as low friction and minimal wear, making it ideal for wear-resistant applications. However, successfully applying SiC through thermal spraying has been challenging. Unlike

* Corresponding author.

E-mail addresses: tunji.owoseni@hv.se (T.A. Owoseni), lidia.baiamonte@enea.it (L. Baiamonte), timothy.dumm@hyperionmt.com (T. Dumm), stefan.bjorklund@hv.se (S. Björklund), shrikant.joshi@hv.se (S. Joshi).

<https://doi.org/10.1016/j.ceramint.2025.03.117>

Received 21 December 2024; Received in revised form 8 February 2025; Accepted 8 March 2025

Available online 10 March 2025

0272-8842/© 2025 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).