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CALPHAD-guided design of a Co-free medium-entropy alloy HVOF coating Abstract

High-entropy and medium-entropy alloys (HEAs/MEAs) can offer exceptional mechanical properties and corrosion/oxidation stability. Consequently, they are increasingly being explored beyond bulk applications as surface coatings through techniques such as thermal spray. However, the use of costly elements in many HEAs/MEAs, particularly cobalt, limits broader industrial adoption. Research on Co-free thermal-sprayed HEA/MEA coatings remains scarce, with Co ranking as the second most frequently used element after Cr. In this work, equilibrium and non-equilibrium CALPHAD screening were combined to identify Co-free compositions in the Al-Cr-Fe-Ni quaternary system that preferentially form BCC/B2 phases under rapid solidification while suppressing FCC and brittle intermetallics. From this screening, a $Al_{1.2}Cr_{0.5}Fe_{0.5}Ni$ MEA was selected, produced via ultrasonic atomisation, and deposited by high-velocity oxygen fuel (HVOF) spraying. XRD, SEM/EDS, and EBSD phase mapping confirmed the targeted BCC/B2 phases. Mechanical evaluation using macrohardness and nanoindentation mapping revealed high hardness and consistent mechanical stability across the coating. Electrochemical corrosion tests in seawater and oxidation tests at 1200 °C further demonstrated the coating's resistance under demanding conditions. Overall, this study demonstrates that CALPHAD can successfully predict phases in thermal-sprayed HEA/MEA coatings and guide the selection of economical Co-free compositions, enabling cost-efficient protective coatings for extreme service environments.

Biography

Ecio Bosi is a PhD candidate in Materials Science at Swinburne University of Technology, where he investigates the design and processing of high-entropy and multicomponent alloys. He earned his M.Sc. in Materials Science and Engineering from the University of São Paulo, where he worked on designing refractory high-entropy alloys. His current research focuses on tailoring multicomponent alloy chemistries for extreme applications by combining thermodynamic simulations (CALPHAD) with thermal-spraying techniques to develop wear-, oxidation-, and corrosion-resistant materials.