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Design of novel wear resistant composite overlay materials

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Abstract

The full operation of mining facilities relies on use of protective alloys and composite overlays to protect against wear and help improve equipment reliability and durability, preventing unplanned shutdowns. Currently, tungsten carbide-based composite overlays are commonly used to protect mining equipment from wear conditions. Due to the aggressive service environment, and cost and supply chain issues, there is an industry need to identify alternative compositions of overlays that can provide equivalent levels of abrasion and impact wear resistance. The aim of this study is to identify and develop substitute alloys and composites that are economically secure, and which may incorporate recyclable materials. The selection of metal carbide powders, primarily titanium and niobium carbides, and associated metal matrix alloys, predominantly ferrous based alloys, was determined by investigating which combination can provide weldability and abrasion/impact resistance equivalent to tungsten carbides. The selection of materials included the use of recycled and reclaimed composite materials. Welding trials were conducted using plasma transferred arc-welding (PTAW). Analysis using metallographic techniques was used to characterize the integrity and quality of the overlay deposits. To further evaluate the overlays, performance testing was carried out under abrasive, erosive and impact wear conditions. The microstructure and wear performance of these materials were compared with standard commercial tungsten carbide-based composite overlay materials to determine their significance to the sector, as it strives to be more economically and environmentally sustainable. Initial samples show that titanium carbide in 410 stainless steel matrix welds well using PTAW and has a homogeneous distribution and high density of carbides throughout the overlay. Although the NbC-410SS overlay did not bond to the surface during the first welding operation, it shows promise with alteration to the welding parameters. Suppliers have also provided recycled titanium carbide powders for investigation which, if results are similar to new TiC powders, would also give scope to produce environmentally maintainable overlays. These preliminary results suggest that there is potential to find more economically and environmentally secure alternatives to tungsten carbide wear resistant overlays.

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