

# Formulation of hybrid-carbide reinforced AISI-4340 wear-resistant composite coatings for remanufacturing of conical picks used in coal mining by laser cladding

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## Highlights

- The consolidated composite coatings formed excellent metallurgical bonding with the substrate.
- Titanium Carbide (TiC) particles were evenly distributed in the

consolidated coating, while the particles of Tungsten Carbide (WC) distinctly settled at the bottom of the clad due to their high density.

- The microstructures of Titanium Carbide–Silicon Carbide (TiC–SiC) coatings revealed minimal defects compared to Tungsten Carbide–Silicon Carbide (WC–SiC) coatings.
- The microhardness and abrasive wear resistance of TiC–SiC reinforced AISI–4340 composite coatings are higher than WC–SiC reinforced coatings.

## Abstract

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The presence of quartz (1100–HV<sub>0.05</sub>) hardness in coal seams results in premature failure of conical picks in the continuous miner (CM) cutter during underground coal mining. This requires that picks are remanufactured with materials that have improved wear resistance, which can withstand quartz. Processability of two laser-cladded hybrid-carbide (WC–SiC and TiC–SiC) reinforced AISI-4340 composite coatings was studied to identify an appropriate material for remanufacturing worn picks with particular attention paid to their microstructural evolution, performance, and costs. WC–SiC reinforced composites were characterised with defective fusion, cracks, and serrations within the clad microstructure, while the morphologies of TiC–SiC reinforced coatings revealed minimal porosity and cracks without serrations. Furthermore, the microhardness of TiC–SiC coatings is between 1102 and 2753 HV<sub>0.5</sub>, compared to WC–SiC coatings with a microhardness range between 1066 and 1365 HV<sub>0.5</sub>. Higher microhardness values of TiC–SiC coatings are attributed to the larger TiC particles retained, compared with the minimal quantity of WC retained particles that settled at the bottom of the coatings. In addition, TiC–SiC coatings have improved wear resistance with a volume loss of 33 mm<sup>3</sup> as compared to 71 mm<sup>3</sup> for WC–SiC coatings. Comparative analysis of the performance and cost indices of hybrid composites with those of TiC–AISI 4340 and WC–AISI 4340 composites suggests that the hybrid TiC–SiC reinforced AISI-4340 composite performs best at a lower cost. Hybrid TiC–SiC reinforced AISI-4340 composite is hereby recommended as a cheaper remanufacturing material for restoring damaged CM's picks to as new in performance or reinforcing newly purchased picks to prolong their service life during coal mining.

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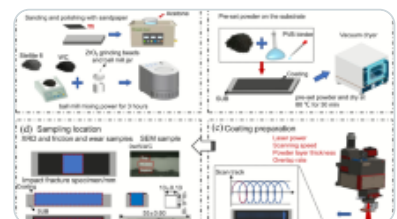
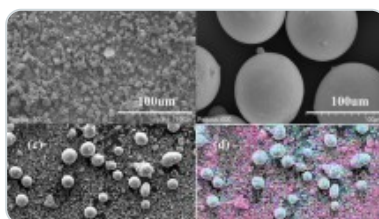
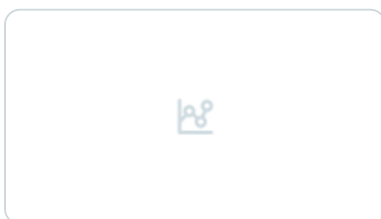
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## Ethics declarations

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