Influence of Ti-Si cathode grain size on the cathodic arc process and resulting Ti-Si-N coatings

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The influence of the Ti-Si cathode grain size on cathodic arc processes and resulting Ti-Si-N coating synthesis has been studied. 63 mm Ti-Si cathodes containing 20-25 at % Si with four dedicated grain size of ~8 µm, ~20 µm, ~110 µm, and ~600 µm were fabricated via spark plasma sintering or hot isostatic pressing. They were evaporated in 2 Pa nitrogen atmosphere in an industrial-scale arc deposition system and the Ti-Si-N coatings were grown at 50 A, 70 A, and 90 A arc current. The composition and microstructure of the virgin and worn cathode surfaces as well as the resulting coatings were characterized using optical and electron microscopy, X-ray diffraction, elastic recoil detection analysis, X-ray photoelectron spectroscopy, and nanoindentation. The results show that the existence of multiple phases with different work function values directly influences the cathode spot ignition behavior and also the arc movement and appearance. Specifically, there is a preferential erosion of the Ti₅Si₃-phase grains. By increasing the grain size of the virgin cathode, the preferential erosion is enhanced, such that the cathode surface morphology roughens substantially after 600 Ah arc discharging. The deposition rate of the Ti-Si-N coating is increased with decreasing grain size of the evaporated Ti-Si cathodes. The droplet number density and the droplet shape of the coatings are influenced by the arc movement, which is also shown to depend on the cathode grain size.

Keywords
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