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Microstructure and tribological properties of CrTiAlN composite coatings with different chemical composition deposited by multi arc ion plating technology

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Abstracts: As an alternative to chromium electroplating for piston rings, one green manufacturing technologies of CrTiAlN composite coatings was introduced in this paper. And the mechanical and tribological properties of CrTiAlN composite coatings was compared with chromium electroplating and CrN films. During the deposition of CrTiAlN composite coatings, the CrTiAlN composite coatings with different chemical composition are deposited on the surface of 65Mn steels by multi-ion plating technology in a gas mixture of $Ar+N_2$. The Metallic ratio of Cr, Ti, and Al was varied by adjusting the currents of different TiAl target. The coatings were characterized by means of energy dispersive X-ray(EDX) analysis, X-ray diffractometry(XRD), scanning electronic microscopy(SEM), microhardness tester, and ball-on-disc tribometer , respectively. The experimental results show that the surface morphology of CrAlTiN films is compact and dense. And the cross-section morphology appears as fibrous columnar structure. Compared with CrN coatings, the preferential growth orientation of CrAlTiN films was changed from CrN (111) to CrN (200) after the addition of Ti, Al element. When the TiAl target arc current was 50A, the hardness reached the maximum value, 35GPa. The CrAlTiN composite films perform better than binary CrN as well as the Cr plating in teams of hardness and wear resistance at high temperature. Then the tribological mechanism at high temperature for the above three kinds of coatings was discussed. It is expected that these advantageous properties can enable the CrTiAlN coatings for a wide range of applications the surface of piston rings.

Keywords
Ion plating
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