아크 이온 증착된 Ti-Al-Cr-N 도포층의 표면 물성 연구

Study on the Surface Properties of Arc Ion Plated Ti-Al-Cr-N Thin Layers

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Abstract : Ti-Al-Cr-N thin layer was prepared on Fe-Si thin sheet by arc ion plating to improve corrosion and mechanical properties. The compositions ratios of Fe : Cr : Al : Ti : Si : N of the thin layers at 500℃ was 1.24 : 0.56 : 36.82 : 32.72 : 0.59 : 28.07 [wt.%], respectively. The higher arc ion plating temperature was, the higher corrosion resistance and nano-hardness were observed due to chromium content. Corrosion potential and corrosion rate in artificial sea water of the coating layer were in the range of -39 mV_{SHE} and 2mA/cm^2, respectively. Passivity was not observed in the artificial sea water. Nano-hardnesses of the thin layers was increased by adding Cr from 23.6 to 25.8 [GPa]. The friction coefficients and fatigue limits of the layers were 0.388, 0.031, respectively.

1. Introduction

Improvement of corrosion and mechanical properties of the thin coating layer has been one of hot issues in the structural thin film research [1]. The properties can be changed by adding transition metal elements like copper and chromium [2]. In this study, chromium was co-deposited in the Ti-Al-N coating and its surface properties like corrosion and nano-hardenss.

2. Experimental Methods

Ti-Al-Cr-N coating layer was prepared by arc ion plating. Microstructure of the specimen was observed by optical microscopy (AT Microscope, MX-3000, Korea) and scanning electron microscopy (Jeol JSM-6400, Japan). Micro-hardness was measured with micro-Vickers hardness tester (HUATEC, DHV-100, China). The corrosion behavior in artificial sea water and nano-hardness were determined with a potentio-dynamic tester (Gamry, Gamry-100, USA) and a tribo-nano indentor (HYSITRON, TI 750, USA), respectively.

3. Results

The Ti-Al-Cr-N surface prepared by arc ion plating at the temperatures of 300 and 500℃ had dents with about 50 nm in diameter. The chemical composition of the ion plated Ti-Al-Cr-N layer with temperature determined by energy dispersive spectroscopy showed that the higher ion plating temperature was, the higher titanium and chromium were deposited and the lower nitrogen was present. The corrosion potential and corrosion rate in artificial sea water of ion plated Ti-Al-Cr-N layers with different arc ion plating temperature were -39mV_{SHE} and 2mA/cm^2,respectively. The nano-hardessses of Ti-Al-Cr-N with arc ion plating temperature were 23.6 and 25.8 GPa, respectively. Ti-Al-Cr-N with arc ion plating temperature at 300 ℃ friction coefficient and fatigue limits by Alekin model were 0.323, 0.030, respectively. Ti-Al-Cr-N with arc ion plating temperature at 500 ℃ friction coefficient and fatigue limits by Alekin model were 0.388, 0.031, respectively.

4. Conclusions

(1) The Ti-Al-Cr-N surface had dents with about 50 nm in diameter. The compositions ratios of Fe : Cr : Al : Ti : Si : N of the thin layers at 500℃ was 1.24 : 0.56 : 36.82 : 32.72 : 0.59 : 28.07 [wt.%], respectively.
(2) Corrosion potential and corrosion rate in artificial sea water were in the range of -39 mV_{SHE} and 2mA/cm^2, respectively. Passivity was not observed in the artificial sea water.
(3) Nano-hardnesses of the thin layers was 25.8 [GPa]. The friction coefficients and fatigue limits of the layers were 0.388, 0.031, respectively.