Study of Corrosion Resistance of AISI 420 Stainless Steel after High Temperature N and Si Ion Implantation

Dept. of Physics & Materials Science, City University of Hong Kong, Kowloon, Hong Kong

The effects of high temperature nitrogen and silicon ion implantation on the corrosion resistance of martensitic stainless steel 420 are investigated. Silicon implantation is used to achieve a Si-rich region near the stainless steel surface to improve the localized corrosion resistance, and plasma nitriding and high-temperature ion implantation are used to further improve the surface microhardness and corrosion resistance. The effects of different substrate temperatures, implantation dose and implantation energy on the surface properties are assessed. The corrosion measurements are carried out in a NaCl solution using electrochemical impedence spectroscopy. The surface microhardness, crystal structure and microstructure are measured by microhardness measurement, XRD, SEM and AES. The process is applied to industrial injection molds in the production line, and the results are reported in this paper.

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Ti-N-O Nano-Films Deposited by Plasma Immersion Ion Implantation and Deposition: Deformation Behavior and Mechanical Properties

G.J. Wan, N. Hussain, H. Sun, P.Y. Yang, Y.X. Long, J.Y. Chen, J. Wang
School of Materials Science and Engineering, Southeast University, Changsha 410031, P. R. China

316L stainless steel is widely used for fabricating biomedical implants owing to its good corrosion resistance as well as its bio-compatibility. To-date many techniques (including PVD, CVD, IBAD, and more), have been used for the surface modification of metallic biomedical implants. However the film/matrix binding strength and the toughness of the films are not adequate to meet the needs of some applications. Ion Beam Assisted Deposition (IBAD) has shown better performance than PVD and CVD due to a broader film/matrix interface and modulated structure of the film. However IBAD can only treat samples of simple shape, having line-of-sight limitations. Plasma Immersion Ion Implantation and Deposition (PIIID) has shown great potential for industrial applications owing to the absence of line-of-sight limitations. Our previous research has shown that Ti-N-O films can improve the blood compatibility of implants substantially. It is well known that TiN films have excellent mechanical properties. Hence, to achieve higher durability as well as excellent blood compatibility, nano-structured Ti-N-O gradient films have been synthesized on stainless steel using PIIIID. Tension tests were performed on Ti-N-O film coated 316L sheet in situ using SEM to observe the plastic deformation of the film. No delamination, peeling or cracking were found on the film after relatively high plastic deformation. The binding strength between the film and matrix was measured by a scratch test method, and the hardness and modulus by nano-indentation tests. High binding strength, hardness and Young's modulus were confirmed. TEM, AFM and AES were used to identify the structure, surface morphology, and depth composition profiles, respectively. Rattle Ti-O and cubic TiN crystals with the grain size about 40 nm were observed. We hypothesized that the excellent mechanical properties of the synthesized Ti-N-O films are attributable to the nano-crystalline structure of the film, their high density, and excellent surface quality as well as a broader film/matrix interface achieved by the PIIIID process.

Key words: Nano-structured film, Ti-N-O gradient film, Mechanical property, PIIIID

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