Effect of Neutralized Nitrogen Species on the Plasma Nitriding Mechanism

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Abstract

Plasma nitriding is one of the nitriding methods. The method is a thermochemical process designed to improve the mechanical properties of metal surfaces such as hardness, wear resistance, and corrosion resistance. The method makes a diffusion layer that is generated on the surface of a nitrided sample, followed by the formation of a compound layer on top of the diffusion layer. The plasma nitriding mechanism is often explained using model has been proposed by Koebel. In this model, Fe sputtering occur at the surface of the treated material by the nitrogen ions (1). As a result of the sputtered Fe atoms, FeN, $Fe_{2\text{-}3}N$ and Fe_4N is formed on the surface. Nitrided layer is formed by the FeN, $Fe_{2\text{-}3}N$ and Fe_4N. However, new plasma nitriding methods such as active screen plasma nitriding which do not occur Fe sputtering have recently been proposed. These plasma nitriding methods cannot be explained using the above models because Fe sputtering of the sample surface does not occur. Further, other methods have proposed in which the sample, are affected by activated neutral N species, NH species, ion bombardment, and more. Thus, plasma nitriding mechanism has not been clarified.

In this study, the plasma nitriding of tool steel was performed by neutral nitrogen beam in the Electron-Beam-Excited-Plasma (EBEP) and the effects of neutralized nitrogen species on the plasma nitriding mechanism were clarified. The results show that the emission spectra around the sample cannot be detected by Optical Emission Spectroscopy (OES) analysis. We consider that the only neutral nitrogen species around the sample were existed from this result.

Reference

(1) D.pye: Practical Nitriding and Ferritic Nitrocarburizing, ASM International, Materials Park, OH, (2003)