

Accepted Manuscript

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PII: S0257-8972(18)30701-1
DOI: doi:[10.1016/j.surfcoat.2018.07.004](https://doi.org/10.1016/j.surfcoat.2018.07.004)
Reference: SCT 23567

To appear in: *Surface & Coatings Technology*

Received date: 24 May 2018

Revised date: 24 June 2018

Accepted date: 2 July 2018

Please cite this article as: M. Naeem, J. Iqbal, M. Abrar, Kamal H. Khan, J.C. Díaz-Guillén, C.M. Lopez-Badillo, M. Shafiq, M. Zaka-ul-Islam, M. Zakaullah, The effect of argon admixing on nitriding of plain carbon steel in N₂ and N₂-H₂ plasma. Sct (2018), doi:[10.1016/j.surfcoat.2018.07.004](https://doi.org/10.1016/j.surfcoat.2018.07.004)

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The effect of argon admixing on nitriding of plain carbon steel in N₂ and N₂-H₂ plasma

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Keywords: Plain carbon steel, surface hardening, cathodic cage plasma nitriding, wear resistance

Abstract

The aim of this study is to assess the effect of argon gas (0-30 %) addition in pure nitrogen and nitrogen-hydrogen admixture on the surface properties of plain carbon steel by cathodic cage plasma nitriding. The surface hardness is obtained using hardness tester, phase composition is evaluated by X-ray diffraction, surface features are observed using scanning electron microscope (SEM) along with energy-dispersive X-ray spectroscopy (EDS) and wear rate is assessed using the ball-on-disc tester. Insignificant change in hardness is found in nitrogen plasma (with or without argon admixing), whereas it is expressively improved in nitrogen-hydrogen mixture plasma. The samples treated in nitrogen atmosphere mainly contains oxides, whereas iron nitrides in the nitrogen-hydrogen atmosphere, both with and without argon. The thickness of the modified layer is drastically changed with gasses composition, and the thick layer is achieved in nitrogen-hydrogen admixture. The wear rate is also significantly improved while using nitrogen-hydrogen mixture, and best results are achieved by using 20 % argon in this mixture. This study reveals that although argon addition can enhance the reactive species production, however the presence of hydrogen is compulsory to improve the surface properties.

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