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Effect of bias on layer formation during two-step plasma nitriding using a cathodic screen

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Recently, considerable efforts have been devoted to the development of alternative nitriding methods such as active screen plasma nitriding (ASPN). ASPN offers several advantages over conventional direct-current plasma nitriding (DCPN) since the plasma is produced on a screen and not directly on the samples. In recent studies, it became clear that S phase (nitrogen supersaturated solid solution), which enables to improve the surface hardness, can be produced by subjecting austenitic stainless steels (ASS) to low temperature nitriding. However, it has been reported that the deposited layer formation on the surface of a nitrided sample may suppress the nitriding layer growth. Since the S phase is formed at a low temperature of 723 K or less for ASS, a long time is required for the nitrogen to diffuse and it is difficult to obtain the thickening of the nitriding layer in a short time. A two-step plasma nitriding constituted of a low-temperature long-time treatment followed by a high-temperature short-time treatment was attempted in order to thicken the S phase during a short time. The samples were nitrided using a cathodic screen with either an insulation state (ASPN) or voltage application state (S-DCPN), and the results were compared. AISI 316L was treated for 14.4 ks at 673 K followed by 1.8 ks at 673 K−873 K at 200 Pa under a 25% N_2 + 75% H_2 atmosphere using a 316L steel screen. After nitriding, the surface hardness tests revealed that the surface hardness increased with an increase in the second step temperature for S-DCPN, whereas decreasing during the second step processing at the temperatures of 823 and 873 K for ASPN. The GD-OES results revealed that the nitrogen diffusion region tended to increase with the increasing of the second step temperature, and the thickness of the layer formed in the case of S-DCPN was wider than that formed in the case of ASPN.

Keywords
active screen plasma nitriding
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deposition, diffusion.
S phase