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Effect of distance between a screen and sample on deposited layer during active screen plasma nitriding

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Plasma nitriding is becoming increasingly popular because of its high nitrogen potential, short treatment time and low environmental impact. Recently, considerable interest has been devoted to alternative nitriding methods such as active screen plasma nitriding (ASPN). ASPN has several advantages over conventional direct-current plasma nitriding because plasma is produced on a screen and not directly on samples. However, according to previous reports, the thickness of a nitriding layer formed by ASPN tends to decrease with increasing distance between a screen and sample. Because little information has been reported on the effect of a deposited layer, we here investigate such a layer formed on a sample surface during ASPN. Furthermore, little information has been reported on the effect of screen-sample distance on deposited and nitriding layers during ASPN. This study aimed to investigate this effect by nitriding an AISI 304 austenitic stainless steel and a silicon wafer by ASPN using a 304 steel screen. The sample was treated for 18 and 54 ks at 673 K under 600 Pa in 25% N2 + 75% H2 atmosphere. The distance between the screen and sample was changed to 10, 100 and 200 mm. After nitriding, the microstructure of the sample was examined by scanning electron microscopy, glow discharge optical emission spectroscopy (GDOES), and X-ray diffraction. GDOES revealed that the thickness of the deposited layer on the nitrided sample surface tended to decrease with increasing distance between the screen and sample. The nitrogen concentration in the deposited layer decreased with increasing distance when the nitriding time was 18 ks; on the other hand, it did not change when the nitriding time was 54 ks. Microstructure observations of the cross-sections of the sample revealed that the nitriding layer thickness did not decrease but increased with increasing screen-sample distance for the same treatment time. These results indicate that the effect of screen-sample distance on the nitriding layer thickness is related to the formation speed of and nitrogen concentration in the deposited layer.

Keywords
active screen plasma nitriding
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surface modification
deposition and diffusion