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Evaluation of Surface Properties and Plasma Nitriding Behavior of B50A125E alloy for Steam Turbine Valve

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INTRODUCTION

Steam turbine valves for generator are critical parts to control high-temperature and steam pressure, which supply to a turbine, and cause a high generation capacity. Therefore, mechanical durability is seriously required in a generating condition. B50A125E alloy (GE spec.) has been used in a nuclear and thermal power generation and treated with a gas nitriding, takes longer time. However, a plasma nitriding has merits such as short time, high surface performance and environment-friendly.

This work dealt with ion nitriding behavior and surface properties in respect to various parameters using plasma nitriding are evaluated.

EXPERIMENTAL

B50A125E alloy was polished, pre-sputtered, nitrided and cooled under a nitrogen gas. Surface and cross-section of the sample were observed using an optical microscope. Hardness of the nitriding layer was measured using a micro Vickers hardness tester. Chemical composition of the layer was evaluated by EDS. Polarization test was conducted at the scan speed 1.0 x 10^{-3} V/sec. High-temperature hardness test was conducted at 200℃.

RESULTS AND DISCUSSION

The sample was pre-sputtered to enhance the surface property before a plasma nitriding. Process factors such as working pressure, gas mixing ratio, temperature and time were investigated to obtain optimum condition. Optimum process parameters such as working pressure (1.5 torr), mixing ratio of gas ($Ar:H_2$=3:1), temperature (500℃) and time (60 minutes) were obtained. Results are obtained in gas mixing ratio of $N_2:H_2$=3:1, working pressure 3.0 torr, and temperature 590℃ in the plasma nitriding.

EDS line profiles on the nitriding layer showed that high chromium was contained in the nitriding layer. XRD patterns indicated that nitride compounds such as CrN, Fe_4N and $Fe_{2\text{-}3}N$ were observed in the nitriding layer.

Hardness of the uppermost surface layer was measured after treating by the gas nitriding layer and the ion nitriding. Vickers hardness of the gas nitriding layer at room temperature was 1,150 and decreased to 425 at 283°C, whereas in the ion nitriding layer, the value was 1,075 and decreased to 495 at 283°C. Activation energy of a nitriding layer formation was 65KJ/mol. Results of polarization test, corrosion-resistance of the nitrided layer by the ion nitriding were superior compare to the gas nitriding.

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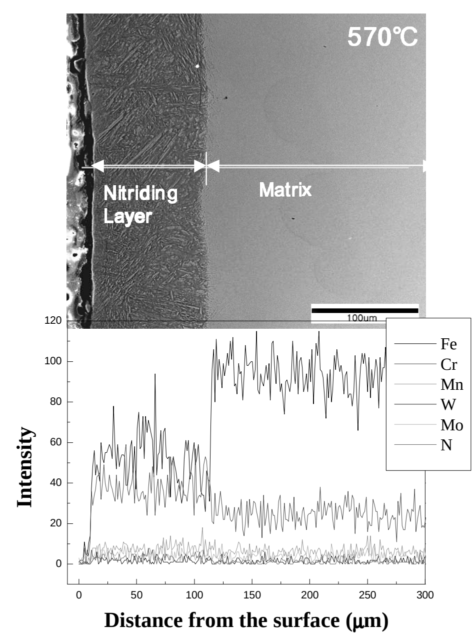

Fig. 1 Optical microscope and line profiles of cross-section in nitriding layer.

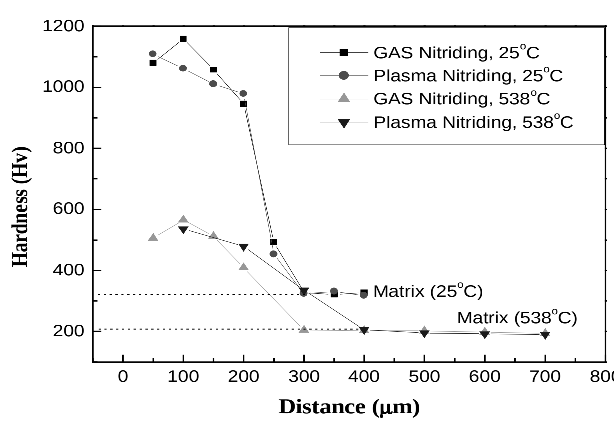

Fig. 2 Cross-sectional hardness changes at 25℃ and 538℃ by the nitriding method.