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Controlling Supplied Nitrogen Concentration in Atmospheric-Pressure-Plasma Nitro-Quenching

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Nitro-quenching (NQ) is a new surface-hardening technology by nitrogen-assisted martensite transformation. This process provides low distortion than carburizing. This technology has been used in automotive companies recently to obtain deep hardened layer after a short time treatment. In this laboratory, we have developed original nitrogen diffusion techniques using pulsed-arc plasma jet generated under atmospheric pressure. With this technique, we have demonstrated atmospheric-pressure plasma NQ. In this technique, hardening of low alloy steel is possible through the formation of iron-nitrogen martensite. Optical Emission Spectroscopy suggested that nitrogen supply into steel surface is carried out via NH radicals present in the jet plume. For now, the atmospheric-pressure plasma NQ has a problem that treated surface were excessively nitrided, which leads to undesirable formation of voids and iron nitride. This excess of nitrogen supply is likely due to the use of atmospheric-pressure plasma. In order to solve this problem, we attempt to decrease NH radical density to suppress the formation of voids and iron nitride. The detail of our method is as follows. According to previous research, the emission intensity of NH radical were decreased by increasing the hydrogen flow ratio of the working gas mixture (N_2 / H_2). Therefore, we examined the method of increasing the hydrogen flow ratio to decrease NH radical density. As a result, the concentration of nitrogen into steel surface was decreased. Consequently, we succeeded in suppressing the formation of voids and iron nitride in steel surface. In summary, we have developed the method to control NH radical density in our technique. This result also indicates that NH radical plays an important role in our technique.

Keywords
nitro-quenching
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martensite transformation
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