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Behavior of NH Radicals in Atmospheric-Pressure Plasma Jet Nitriding

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We use the pulsed-arc plasma jet for developing a novel atmospheric-pressure plasma nitriding. Although nitriding of steels and titanium has been succeeded, research on elementary process has not been performed yet. Therefore, we measured the behavior of NH radicals as the key radical in our technique. In our nitriding process, we introduce nitrogen hydrogen gas mixture into as operating gas. By performing emission spectroscopic analysis, we found that the hydrogen-dependent characteristics of NH radicals are different between the pulsed-arc discharge and the jet plume. In the pulsed-arc discharge, we observe that as the ratio of hydrogen increases, the emission of the NH radical monotonically increases. On the other hand, in the jet plume, the emission of the NH radical increases until the ratio of hydrogen reaches a certain level, but it decreases with further increase in the ratio of hydrogen. These experimental results may provide the following scenario. It is well known that NH_3 thermally dissociates under high temperature. The temperature of the pulsed-arc discharge is several thousands Kelvin and that of the jet plume is approximately or less than 1000°C. Since the temperature of the jet plume is much lower than that of the pulsed-arc discharge, we consider that NH radical is stabilized in the state of NH_3 in the jet plume as the ratio of hydrogen increases. On the other hand, the produced NH cannot become NH_3 in the pulsed-arc discharge. We concluded that the temperature difference results in the difference of the hydrogen-dependent characteristics of NH radicals.

Keywords
nitriding
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