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Improvement of Hardness and Toughness by Combined Heat Treatment of High Temperature Plasma Nitriding and Austempering

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The steel used for machine components is heat treated (e.g. carburizing and nitriding) in order to improve wear resistance and fatigue strength. However, they have some disadvantage. In carburizing, deformation is occurred and it exhausts greenhouse gas. In nitriding, the treating time is long. Nitrogen infiltrating and quenching, which is named “N-quench” has many good properties. In this treatment, specimen is quenched after the nitrogen is infiltrated about 1000K or more in Fe-N austenite phase, so the distortion is lower than carburizing, and the treating time is shorter than nitriding. However, N-quench uses NH_3, which is not safety for human.
Novel heat treatment process high temperature plasma nitriding, which is called “plasma N-quench”, that applies plasma to activate the nitrogen for infiltrating instead of the NH_3 and austempering which is an isothermal heat treatment, when applied to steels, that produces a structure that is harder and tougher than comparable structures produced with quenching treatments are combined for improvement of hardness and toughness.
The hardenability of low carbon steel is low because it is not included the alloy elements, therefore it is difficult to improve hardness and toughness by austempering treatment. If the nitrogen content of steel is increasing, the hardenability is increased. In this study, plasma N-quench process is used for increasing the nitrogen concentration and hardenability and austempering is used for increasing the toughness. In fact, combined heat treatment was applied to JIS-S45C steel to realize improvement in hardness and toughness. The toughness value of combined heat treated specimen was 4 times that of the quenched and tempered specimen, and a hardness of 10% higher than that of the same toughness value specimen which was treated only with the austempering was obtained.

Keywords
Plasma Nitriding
Austempering
Low Carbon Steel