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The role of bias activation in the large industrial scale ASPN-system

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A novel active screen plasma nitriding (ASPN) process provided excellent temperature homogeneity in the load and showed further progress in the control of nitriding potential. The main difference of the ASPN to conventional plasma process is the replacement of the glow discharge from the components to a separate metal mesh screen (active screen, AS) surrounding the entire workload. A two-fold function of the AS is an essential characteristic of the ASPN process, i.e. heating of the workload via radiation and generation of the reactive gas species, which are responsible for the nitriding process. The principles of the ASPN process are based on the well-known phenomenon of nitriding in the afterglow plasma. In most previous investigations, the small laboratory scale ASPN furnaces have been almost always preferred. A relatively small metal cage (active screen) of several tens of centimeters in diameter was directly contacted to the cathodic worktable whereas the steel samples were placed floating on the isolated stage inside the active screen. However, the knowledge obtained on the laboratory scale ASPN equipment cannot be directly transferred to the large industrial scale ASPN systems. For example, the application of cathodic bias activation to the load rather than floating potential was found to be very essential for the ASPN units of industrial scale to achieve an appropriate nitriding response comparable to that after the conventional plasma treatment. A mechanism of bias activation in the ASPN process is still not fully understood. In the present study, a systematic investigation of the bias activation has been performed in the large industrial scale ASPN system under variation of different process parameters such as the process gas composition, the pulsed-mode of bias generator as well as the power applied to the active screen. A powerful and non-invasive diagnostic method - optical emission spectroscopy (OES) - has been in-situ applied in this work to investigate the plasma activation processes both in the vicinity of active screen and near the biased worktable. A correlation to the metallurgical results of the nitriding experiments obtained for different steel grades has been done.

Keywords
active screen plasma nitriding, bias activation, OES