OR2304

The role of active species in active screen plasma nitriding with addition of CH4 – spectroscopic and metallurgical study

Igor Burlacov¹, Kristian Börner¹, Heinz-Joachim Spies¹, Horst Biermann¹, Stephan Hamann², Marco Hübner², Jürgen Röpcke²

¹IWT, TU Bergakademie Freiberg, Freiberg, Germany ²INP Greifswald, Greifswald, Germany

burlacov@ww.tu-freiberg.de

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) surrounding the entire workload. Highly reactive gas species are produced on the active screen and directed towards the component surface. The principles of the ASPN process are based on the well known phenomenon of post-discharge nitriding. Excited neutrals in different excitation states and atomic nitrogen were found to play a decisive role in the nitriding process during the post-discharge. Recently, the low admixtures of methane (below 1%) in the process gas have indicated a considerable increase of nitrogen mass transfer due to chemisorption phenomenon. For example, addition of 0.25% of methane to the process gas leads to the significant increase of nitrogen surface concentration and diffusion depth. The activation effect of methane can be attributed to the CN and HCN radicals generated in the N₂-H₂-CH₄ plasma. For the first time a combination of several powerful optical spectroscopic methods: in-situ mid infrared tunable diode laser absorption spectroscopy (TDLAS) and ex-situ Fourier transform infrared spectroscopy (FTIR) together with the optical emission spectroscopy (OES) has been applied in this work. In-situ diagnostics of chemical phenomena in the N₂-H₂-CH₄ plasmas under variation of the process conditions such as process gas composition with different admixtures of CH₄, process temperature, working pressure and bias activation power have been carried out in the large industrial scale ASPN system to obtained valuable information about the concentration of active species in the vicinity of the sample surface. A correlation to the metallurgical results of nitriding experiments performed for selected process conditions should give us a clear hint about the effective mechanisms of nitriding.

Keywords
Active screen plasma nitriding, N₂-H₂-CH₄ plasma, TDLAS, FTIR, OES