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Quantitative determination of the species produced in low pressure N2-H2 plasmas by in-situ mass spectrometry

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Plasmas created from N_2-H_2 gas mixtures are extensively applied in surface treatment and functionalization processes. Amongst these processes, plasma nitriding is a well-established process during which a nitrogen diffusion layer is created inside a bulk material. The aim of this process is to modify surface properties of the treated material such as mechanical properties (hardness, wear resistance, …), corrosion resistance, surface roughness, surface patterning, … However, in the case of plasma created in N_2-H_2 gas mixture, the exact role played by H_2 addition is not clearly yet understood. A better understanding of the fundamental mechanisms inherent to these discharges could increase their potential. In this work, N_2-H_2 plasmas were generated by Distributed Electron Cyclotron Resonance (DECR) in a reactor specially designed for low pressure plasma nitriding. When the N_2 gas flow is increased in a constant H_2 gas flow plasma, the presence of an unexpected minimum pressure is observed. In order to understand the origin of this pressure behavior, the neutral species composition of the plasma phase has been characterized by the means of Mass Spectrometry (MS). The MS measurements show that the pressure decrease is associated to the production of a high ammonia concentration (up to 20% in our experimental conditions). The ammonia signal increases to reach a plateau as the nitrogen gas flow rate increases. This plateau is reached when the pressure is minimum. Others results concerning the evolution of atomic nitrogen and hydrogen, and NHx species will be also presented. MS measurements have also been performed within nitriding process experimental conditions (90% N_2, 10% H_2). Comparison between plasma properties and nitrided layer properties obtained in these conditions will be presented.

Keywords
mass spectrometry
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