Spectroscopic diagnostics of hydrogen radicals in EUV induced hydrogen plasma

ILE Osaka Univ. [1], Mechatronics R&D Center, Samsung Electronics Co. Ltd.[2],

Samsung R&D Institute Japan[3]

°(D) Chang Liu[1], Nozomi Tanaka[1], (P) Baojun Zhu[1], Kyung Sik Kang[2], Youngduk Suh[2],

Jeong-Gil Kim[2], Ken Ozawa[3], Takeshi Takagi[3], Minoru Kubo[3], Shinsuke Fujioka[1]

E-mail: changliu@ile.osaka-u.ac.jp

The EUV light source is widely used in the semiconductor engineering applications as the technology named Extreme ultraviolet lithography (EUVL). Today EUVL utilizes laser ablation of Sn droplets as the EUV source. Since Sn contamination on the first Mo/Si mirror and following deterioration of the reflectance has been critical issue for sustainable operation of the source, many EUV sources now introduce H_2 gas to the chamber trying to clean the Sn layer. Hydrogen atom in excited electron state, so called as "hydrogen radial H*", is known for its chemical reaction to form stannane ($Sn + 4H^* \rightarrow SnH_4$), which is gaseous states in room temperature. A H_2 molecule also interact with a photon from the EUV source resulting in Hydrogen radical formation ($hv + H_2 \rightarrow e^- + H^* + H^+$), This study aims to verify the feasibility of using EUV induced H* radicals for cleaning of Sn layers seeking the optimum parameters for H* production. First, we need to determine the parameters which effect the H* yield. Secondly, the H* numbers should be large enough to clean the Sn ions. For these purposes, an Optical Emission Spectroscopy (OES) system was used to measure the H* yield in the H_2 / EUV interaction. A laser produced Xe plasma EUV source at Institute of Laser Engineering was used in the experiment. The OES systems consist of a set of optical system, a spectrometer and control systems. H-alpha (wavelength) and H-beta (wavelength) line emissions from the electron transitions of n = 3 to n = 2 and n=4 to n=2 respectively were detected showing the existence of the hydrogen radicals. From the OES data, the Hydrogen plasma parameters and the H* yield can be derived. An atomic spectrum simulation code CHIANTI which based on the NIST database will also be used to verify the results. Together with the experimental results, we are going to present the H* yield and its dependence on the operational parameters.