Spectroscopic diagnostics of H-radicals formed by an extreme ultraviolet light source generated with a laser produced plasma

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Extreme ultraviolet (EUV) sources mainly play a crucial role in photolithography, enabling the production of the nanometer-scale transistors. One of the main production mechanisms of EUV light is through laser-produced plasma (LPP), where the target undergoes transition and emits light at 13.5 nm wavelength, along with visible light, upon recombination. In typical photolithography equipment, tin droplets serve as target materials and are ablated to produce EUV light. As a result, the ablated products scatter along the direction of plume expansion, including the reflection optics employed to redirect EUV light. These ablated products consist of tin ion and neutral particles, where the deposition to the reflection optics results to lithography equipment downtimes for cleaning and maintenance. An implemented method in cleaning tin debris involve introducing a hydrogen buffer to the system, mitigating the tin ion deposition via the reaction of tin ions with hydrogen ions forming SnH_4, a compound which can be evacuated [1, 2]. While hydrogen ions are utilized for debris mitigation, little attention is paid on the H radical production, which is a product of EUV-induced H2 gas. In this work, hydrogen radicals produced by EUV LPP are investigated spectroscopically.

A YAG laser (10 Hz, 1064 nm) is incident on a rotating copper drum target containing solid xenon cooled by liquid nitrogen with a laser intensity of 4×10^{11} W/cm^2. The LPP produces EUV, which is focused using two gold ellipsoidal mirrors towards a stainless-steel hydrogen gas cell. The gas cell is maintained at a pressure of 5 Pa and is differentially pumped from the surrounding chamber. Hydrogen radical spectra emissions corresponding to H_α and H_β transitions are collected using an ICCD camera attached to a monochromator centered at 656.3 and 486.13 nm, respectively. The spectra time evolution, as well as the effects of laser intensity on the spectra are investigated.

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