Contribution ID: **63** Type: **not specified**

Production of singly charged Sn ions by charge exchange in H_2 gas

Wednesday 17 May 2023 12:20 (20 minutes)

The evolution of charge-state-resolved kinetic energy spectra of Sn ions ejected from a laser-produced plasma (LPP) of Sn as a function of the density of the H_2 buffer gas surrounding the LPP is investigated. Without a H_2 buffer gas, energetic 1 - 5 keV Sn ions in charge states of 4+ up to 8+ are detected. In this keV regime, lower Sn charge states, i.e., below 4+ are absent. When H_2 is introduced into the system, low-charged energetic Sn ions can be produced by a series of consecutive electron capture processes. However, as electron capture by Sn^{2+} ions from H_2 is endothermic, no significant population of singly charged Sn ions is expected in the keV regime. At H_2 pressures of 6x10^{-4} mbar and higher, however, we only detect Sn^{2+} and Sn^{+} ions.
To explain the production of keV Sn^{+} ions, electron capture by metastable Sn^{2+*} ions has been proposed [1]. Semi-classical calculations on Sn^{3+}- H_2 collisions [2] indicate that one-electron capture by Sn^{3+} ions populates Sn^{2+} ions in metastable states. Model simulations (using theoretical 2-state Landau-Zener cross sections to account for capture by each of the three metastable ^3P_J levels) to track the charge states of Sn ions while traversing the H_2 gas agree with our measured data. This underpins the key role of metastable Sn^{2+*} ions as a gateway to the production of Sn^{+} ions. From an LPP-based EUV source perspective, the production of energetic Sn^{+} ions in the buffer gas is of high relevance, as it shifts the charge state balance from Sn^{2+} towards Sn^{+} ions, which have a larger stopping cross section than Sn^{2+} ions [3].

[1] Rai et al., 2023 to appear in Plasma Sources Sci. Techn.
[2] Rai et al., 2022, Phys. Rev. A. **106**, 012804
[3] Abramenko et al., 2018, Appl. Phys. Lett. **112**, 164102

Presenting Author

Luc Assink

Presenting Author Affiliation

University of Groningen

Presenting Author Gender

Male

Country

Netherlands

Presenting Author Email Address

l.assink@rug.nl

Author: ASSINK, Luc (University of Groningen)

Co-authors: BIJLSMA, Klaas (University of Groningen); Mr POIRIER, Lucas (Advanced Research Center for Nanolithography); DE WIT, Emiel (University of Groningen); RAI, Subam (University of Groningen); RABADÁN, Ismanuel (Universidad Autónoma de Madrid); MÉNDEZ, Luis (Universidad Autónoma de Madrid); Dr SHEIL, John (Advanced Research Center for Nanolithography); VERSOLATO, Oscar (Advanced Research Center for Nanolithography); HOEKSTRA, Ronnie

Presenter: ASSINK, Luc (University of Groningen)

Session Classification: Fundamental Data and Modelling

Track Classification: Fundamental Data and Modelling