

# SPECTROSCOPY OF HIGHLY CHARGED TIN IONS FOR AN EXTREME ULTRAVIOLET LIGHT SOURCE FOR LITHOGRAPHY

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Laser-produced tin plasmas are the prime candidates for the generation of extreme ultraviolet (EUV) light around 13.5 nm in nanolithographic applications. This light is generated primarily by atomic transitions in highly charged tin ions:  $\text{Sn}^{8+}$ - $\text{Sn}^{14+}$ . Due to the electronic configurations of these charge states, thousands of atomic lines emit around 13.5 nm, clustered in a so-called unresolved transition array. As a result, accurate line identification becomes difficult in this regime. Nevertheless, this issue can be circumvented if one turns to the optical: with far fewer atomic states, only tens of transitions take place and the spectra can be resolved with far more ease. We have investigated optical emission lines in an electron-beam-ion-trap (EBIT), where we managed to charge-state resolve the spectra. Based on this technique and on a number of different *ab initio* techniques for calculating the level structure, the optical spectra could be assigned [1,2]. As a conclusion the assignments of EUV transitions in the literature require corrections. The EUV and optical spectra are measured simultaneously in the controlled conditions of the EBIT as well as in a droplet-based laser-produced plasma source providing information on the contribution of  $\text{Sn}^{q+}$  charge states to the EUV emission.

[1] A. Windberger, F. Torretti, A. Borschevsky, A. Ryabtsev, S. Dobrodey, H. Bekker, E. Eliav, U. Kaldor, W. Ubachs, R. Hoekstra, J.R. Crespo Lopez-Urrutia, O.O. Versolato, Analysis of the fine structure of  $\text{Sn}^{11+}$  -  $\text{Sn}^{14+}$  ions by optical spectroscopy in an electron beam ion trap, *Phys. Rev. A* 94, 012506 (2016).

[2] F. Torretti, A. Windberger, A. Ryabtsev, S. Dobrodey, H. Bekker, W. Ubachs, R. Hoekstra, E.V. Kahl, J.C. Berengut, J.R. Crespo Lopez-Urrutia, O.O. Versolato, Optical spectroscopy of complex open 4d-shell ions  $\text{Sn}^{7+}$  -  $\text{Sn}^{10+}$ , arXiv:1612.00747