MODELING OF SHORT WAVELENGTH SOURCE on the base of tin plasma

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Sources of short (extreme) ultraviolet radiation are necessary for future lithography to produce highly packaging integrated circuit elements with details less than ~ 10 nm. Such sources are based on tin plasma produced by CO2 laser and have very high efficiency in the wavelength range around 13.5 nm. The tin plasma at density of 1019 1/cm3 and at temperature of ~ 50-100 eV up to tenfold ionization is optically thick, and the level kinetics coupled with the radiation transport in many ways determine the dynamics of such a plasma.

After the laser pre-pulse with duration of ~ 30 ns relatively low intensity (with energy ~ 20 mJ and pressure P ~ 2 kbar), a droplet of liquid tin diameter of 30 μ disintegrates into fragments of ~ 1 μ in time ~ 1 ms. To simulate this process there was used open package OpenFoam.

To describe the plasma dynamics after the main laser pulse onto the target, broken into fragments, there was used 2D code RZLINE, which includes refraction, reflection and absorption of the laser radiation, time-dependent ionization, electron and ion conductivity, spectral transport of nonequilibrium radiation and so on. To account for radiative processes there was used THERMOS-BELINE package, which enables self-consistent calculation of radiative transfer in overlapped spectral lines together with level kinetics of multiply-ionized non-stationary plasma in different geometries. Some results of calculations are presented on Fig.1-2. The optimization of conversion efficiency over laser pulse parameters and target forms were fulfilled.



Fig.1. Modeling of main pulse action on preconditioned target



Fig.2. Snopshot, anisotropy and spectrum of tin source