Modeling of ablation of the target material for the plasma for coherent and incoherent EUV sources

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Abstracts: *Initial interaction between the target and laser pulse for the excitation of plasma x-ray lasers and EUV sources is investigated using a hydrodynamics model, which takes liquid gas phase transition and particle emission from the ablation of the target material into account. Investigations are carried out for the irradiation of relatively weak pre-pulse laser pulse, which produces particles and decides further heating by the main laser pulse and EUV emission.*

For the excitation of plasma x-ray lasers and EUV sources the metal target is irradiated by intense laser pulses, and multiple charged ions are produced in hot plasmas. By the irradiation of relatively weak pre-pulse laser, it is expected that pre-formed plasmas is produced, however, sometimes particles are produced from the target. Particles may be useful for the efficient EUV emission because the absorption of the energy of the main pulse laser is enhanced, however, they also cause a non-uniform density profile in the plasma, which have detrimental effects of the amplification of x-ray laser light.

We develop a hydrodynamics model to investigate instabilities and particle emission during the melting and evaporation processes of the target material after the laser irradiation. The model is based on the two-dimensional Lagrange hydrodynamics, which includes mesh reorganization algorithms to calculate dynamics of small liquid particles in gas phase as well as gas bubbles in the liquid phase. Production of particles and bubbles are calculated using a phase transition model based on the Van-der-waals equation of state of Sn that will be used for the light source at λ=13.5nm for the EUV lithography.

A test calculation is carried out for the expansion of an initially hot (T=3,000K) liquid Sn cylinder with a radius of 10μm, which shows that although initially particles are formed, all materials are evaporated in a short time (<100ns). Conditions to obtain a shell structure of particles, which is observed in the experiments, are investigated.

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