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SOLID Xe TARGET GENERATOR FOR LASER–PLASMA EUV NANOLITHOGRAPHY SOURCE *)

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Throughout years of development of the semiconductor industry it was possible with the help if technology of photolithography to improve the standards of the technological process from 3 μm to 10–20 nm. Further improvement of these standards is planned to be done by means of nanolithography in extreme ultraviolet (EUVL – Extreme Ultraviolet Lithography) for it could satisfy the needs of modern microelectronics. Currently, laser-plasma radiation sources with target in the form of Sn droplets and with a wavelength of $\lambda = 13.5$ nm are used in lithographs to obtain extreme ultraviolet radiation. Optical systems made of multilayer Si/Mo mirrors are used for such radiation.

A significant drawback of EUV lithographs with target made of Sn is the low operating life of expensive optical elements due to rapid contamination. Attempts to solve this problem significantly increase the cost of the system, but do not lead to huge success [1].

As an alternative to the target made of Sn, a variant of a gas-jet target made of Xe with a radiation wavelength $\lambda = 11.2$ nm is considered. In this spectral range, the optical system has Be-containing multilayer interference mirrors [2]. In the studies conducted at the Ioffe Institute of such a source, a sufficiently high efficiency of conversion of a laser pulse into EUV radiation CE = 4% was demonstrated [3]. However, at the same time, the nozzle from which the Xe is injected is located at a distance of ~1 mm from the area in which the laser-plasma torch should burn. This leads to rapid degradation of the material of the nozzle.

The authors of this report suggest using an echelon of solid Xe pellets as a target. This idea solves the problem of a nozzle located a few millimeters from the laser plasma. A jet of liquid xenon in the pellet-target generator breaks up into droplets because of the development of the surface instability of the Plateau-Rayleigh. Evaporation from liquid surface leads to cooling of the droplet and to phase transition to a solid state. In this way, a stream of solid particles moving one after another is formed. The possibility of forming an echelon of pellets with parameters close to those required in the lithograph has been successfully demonstrated for liquid hydrogen [4] and for Xe [5]. The report presents results of modelling and experimental activities on the creation of a target generator.

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