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CONDITIONS AND DESIGN OPTIONS FOR THE TARGET FORMATION DEVICE FOR GENERATING X-RAY RADIATION *)

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An exponential law of computing growth demands an increase in the packing density of transistors, which in photolithography leads to the need to reduce the wavelength of exposure of the wafer to a possible theoretical limit which in practice results in the necessity to use the ultraviolet and X-ray part of the spectrum.

Plasma-laser generators are promising because they have a relatively small size and allow operation over a wide range of wavelengths and intensity levels [1]. Actually the source of radiation is plasma, which is created by optical discharge at the focus of the laser beam on the target material. Using vapors of refractory rare-earth elements, such as gadolinium or terbium, the highest conversion efficiency of shortwave radiation with a wavelength of 6.7 nm is achieved.

The best option for a plasma target formation device to generate x-ray radiation is to use gadolinium (Gd) vapor [2].

In this paper, we discuss the conditions and design options for a target formation device (TFD) based on gadolinium vapor for generating radiation with a wavelength of 6.7 nm, similar to the alkali metal vapor plasma generator designed by Keldysh Research Center.

Estimations and calculations of the operating conditions for a TFS, such as the required particle concentration and thermodynamic and gas dynamics, have been conducted. It is noted that the physisorption of gadolinium vapor on the inner surface of the X-ray generator can reduce the conversion efficiency; therefore the rate of adsorption was estimated. The design of a TFD, which fulfill these requirements using the tungsten-rhenium alloy VR-27 VP, was proposed and described. As a heater we propose to use the outer heating by electron beam generators (EBG) [3]. EBGs are able to operate directly in buffer gas (helium or argon) at medium pressure. According to the previously proposed technique [4], the required parameters of the EGP, such as the electrons mean path and the power of the electron beam, were estimated. The energy efficiency of heating using an electron beam has been estimated.

The manufacture of a TFD as a source of X-ray radiation seems achievable, but further detailed studies are needed. Modeling TFD using less expensive molybdenum would allow us to confirm the basic possibility of creating such a device and verify the joint operation of its parts.

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