Simulation of accumulation of low-temperature extreme-ultraviolet-induced plasma of Ar, He and H_2

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Extreme-ultraviolet (EUV) lithography solves the task of gas protection of the chamber from contamination by a continuous flow of buffer gas [1]. Argon (Ar), helium (He), and hydrogen (H_2) have the best transmittance in this spectral range [2]. The characteristic gas pressure in the EUV photolithograph scanner is several pascal, and the temperature is 300 K [3]. The buffer gas ionization is the result of EUV radiation passing through the chamber. A series of consecutive EUV pulses causes plasma accumulation. The electrons generated in the next pulse interact with the pre-accumulated plasma. This leads to a change in the distribution of absorbed energy between the excited states of the buffer gas, the heating of electrons and the ionization of the buffer gas. In this study, we investigate the effect of plasma accumulation in the chamber on the energy distribution among the formed states following the next EUV pulse using the particles-in-cell simulation. The plasma of three different gases (Ar, He, and H_2) is compared. The pressure of the buffer gases is selected according to the same transmission coefficient. Three levels of plasma accumulation are considered: 1x is no plasma in the chamber and only neutral gas, 10x and 20x are concentration estimates obtained after 10 and 20 consecutive pulses, respectively.

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[2] Harilal S S *et al.* 2007 *Appl. Phys.B* **86** 547–553

[3] Bakshi V 2018 *EUV Lithography* 2nd ed (Bellingham, WA, USA: SPIE Press)