Ion beam lithography: sensitivity/contrast measurement in comparison to EBL

Shabelnikova Ya.L.[1], Zaitsev S.I.[1], Gusseinov N.[2], Gabdullin M[3], Muratov M.M.[2]

[1]Institute of microelectronic technology RAS, Chernogolovka, Moscow distr., 142432, Russia

[2]Al-Farabi Kazakh National University, Almaty, Kazakhstan

[3] Kazakh-British Technical University, 59 Tole bi, Almaty 050000, Kazakhstan

ABSTRACT

The feature of the promising tool of lithographic nanostructuring based on selective exposure of polymer resist by ion beam is very compact (of about tens of nanometers) beam interaction volume. Herewith the main part of beam energy is deposited in the resist and is spent to its modification. It causes the set of advantages specific for this method: sub-10 nanometer resolution achievable, very high energy efficiency and almost complete absence of proximity effect.

In the present work the first and rigorous sensitivity comparison of the most used positive-tone resist (PMMA 950K) exposure to both electrons and gallium ions in a wide range of exposure doses at the same beam energy was carried out. It was found that the PMMA 950K resist has a positive sensitivity of 0.15 C/cm2, which is more than three orders of magnitude more sensitive to gallium ions than to electrons, all at the same conditions. At high Ga exposure doses, as well as with electron exposure, negative sensitivity was measured resulted to ~2000 ratio of sensitivities.

The depth of the resist after etching in a solvent depending on the exposure dose was also studied. But absorbed doze was essentially inhomogeneous in resist and the dissolution rate was strongly dependent on depth. So the common procedure of resist contrast determination could not be applied anymore. In the present work a new method for resist contrast determination considering the relation between dissolution rate and deposited energy density was suggested and realized. By using it for PMMA resist irradiated by 30 keV Ga + ion beam the value of contrast was determined to be 1.9 and ions Bethe range (energy length) was estimated to be 42 nm.