ION BEAM LITHOGRAPHY: SENSITIVITY AND CONTRAST OF PMMA RESIST DETERMINATION

Ya.L. Shabelnikova1), S.I. Zaitsev1)

1) Institute of microelectronic technology and high purity materials RAS, Chernogolovka, Russia

For various reasons at present ion beam lithography (IBL) is insignificant in comparison to the position of the electron-beam lithography in spite of IBL has certain advantages. Ions move in straighter and shorter paths than electrons, secondary particles (mainly atoms) have very short ranges because of a lower speed of the ions. So the energy of heavy ions deposits in a very small volume of resist. Therefore, this method should be of higher efficiency and resolution than electron beam lithography. In order to estimate quantitatively the efficiency of resist employing ion beam lithography, the sensitivity of PMMA resist to ion beam irradiation were determined and compared with its sensitivity to electron exposure. It was shown that as in the case of electron exposure the resist demonstrates both a positive (at low doses) and negative (at higher doses) behavior. The value of resist sensitivity was determined to be approximately a thousand times higher for ion beam irradiation than for electrons both in positive and in the negative regions.

Another important result reported in this work is the procedure of resist contrast determination. It was noted that in ion lithography the energy absorbed in resist and, consequently, its etching rate are strongly inhomogeneous in depth. The model of etching rate being proportional to absorbed energy density in the power of γ (γ is the contrast) was the basis to derive the dependence of etching depth on exposure doze. The expression derived was used to approximate the measured dependence. The contrast and energy length of ions was two fitting parameters. The value of contrast *γ* = 3.1 and the mean path of ions in the PMMA *Lenergy* = 43 nm was restored. This value is approximately 20% less than the energy length obtained from TRIM data (53 nm). This difference can be caused by the imperfection of the formulas (interaction cross sections of TRIM) embedded in the modeling algorithm, as well as by the simplicity of the development model.