Electron beam lithography - lab report example

Electron Beam Lithography

Factors Affecting Linewidth in EBL Electron Beam Lithography (EBL) is the process of using a focused beam of electrons to form circuit patterns on wafers that are needed for material deposition on them (Silicon Far East 2004). This technique offers a very high patterning resolution due to the extremely short wavelengths of the 10-50 keV electrons that are used for the beam. This pattern resolution, or the linewidth, is affected by a number of factors, which include amount of dosage, input current and numerical aperture (Rai-Choudhury). By controlling these factors, the linewidth can be adjusted to correspond with the requirements of a given circuit.

The linewidth has a directly proportional linear relation with the dosage provided. Lower dosage results in a decrease of linewidth; though at very low quantities, line discontinuity dominates. The relation that defines Line Dose is-

Therefore, a change in line dose (which in turn affects linewidth) can be brought about by altering the beam current, dwell time or line step-size (with the last one being inversely proportional to linewidth values).

The thickness of Polymethylmethacrylate (PMMA), which is often used as a resist in EBL, also has a linearly proportional relation with linewidth (Deng et al 2005). A reduction in PMMA thickness thins down the linewidth, and this can be done by either diluting the PMMA using Chlorobenzene, or using A series PMMA (in Anisole). Pattern resolution is primarily limited by either aberrations, or space charge. Furthermore, the feature resolution limit is determined by the forward scattering (effective beam broadening) in the resist, and the pitch resolution limit is determined by the secondary electron travel in the resist (Broers et al 1996).

Reducing the beam spot size results in a decrease of the linewidth. The beam spot size is determined by two factors - the beam current (I), and the numerical aperture () - and hence, linewidth is also affected when a change is brought about in any of these factors. The formula for beam spot size (d) is given as-

By reducing the aperture size, a smaller beam current can be produced which leads to thinning of the linewidth (Deng et al 2005). By shortening the working distance appropriately, the numerical aperture can be increased and this inversely affects values of linewidth. A reduced beam current makes focusing difficult, which is yet another factor affecting linewidth. Focusing is generally optimized through the adjustment of stigmation and aperture alignment.

Works Cited

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