Writing strategies for sub-10nm patterning node.

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Abstract

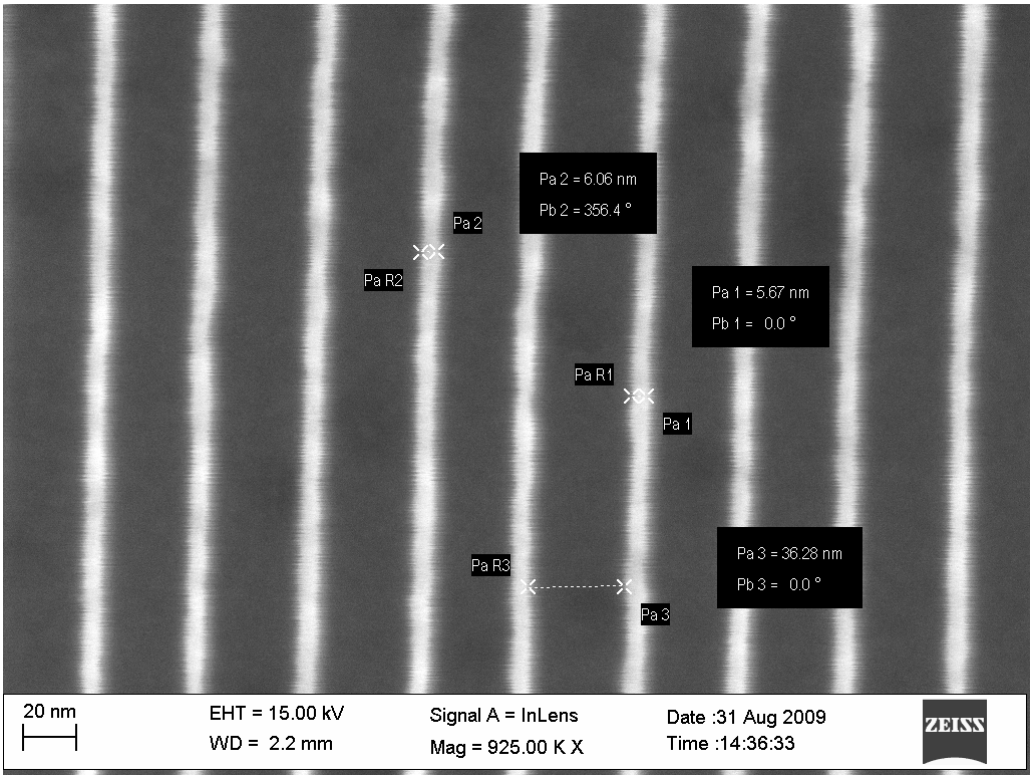
The electron beam direct writing (EBDW) has been extensively used in various applications such as prototyping or small volume production of electronic devices. It suffers from proximity effects which, originally, were considered as a presence of the background energy difference caused by the pattern density distribution. However, when the critical dimensions of the target patterns are getting smaller, the influence of the forward scattering cannot be ignored. Indeed, when the critical dimension is close to 2 times of the forward scattering range, its influence must be carefully analyzed. In case of the fabrication of the sub-10 nm pattern dimensions by the nano imprint lithography (NIL), which requires the original dimension (1:1) molds, the proximity effects correction system which considers forward scattering in the complete way is of the utmost importance.

We have developed PATACON PC-Cluster, the simulation-based proximity effects correction system combined with the data format conversion which works in Linux PC cluster environment.

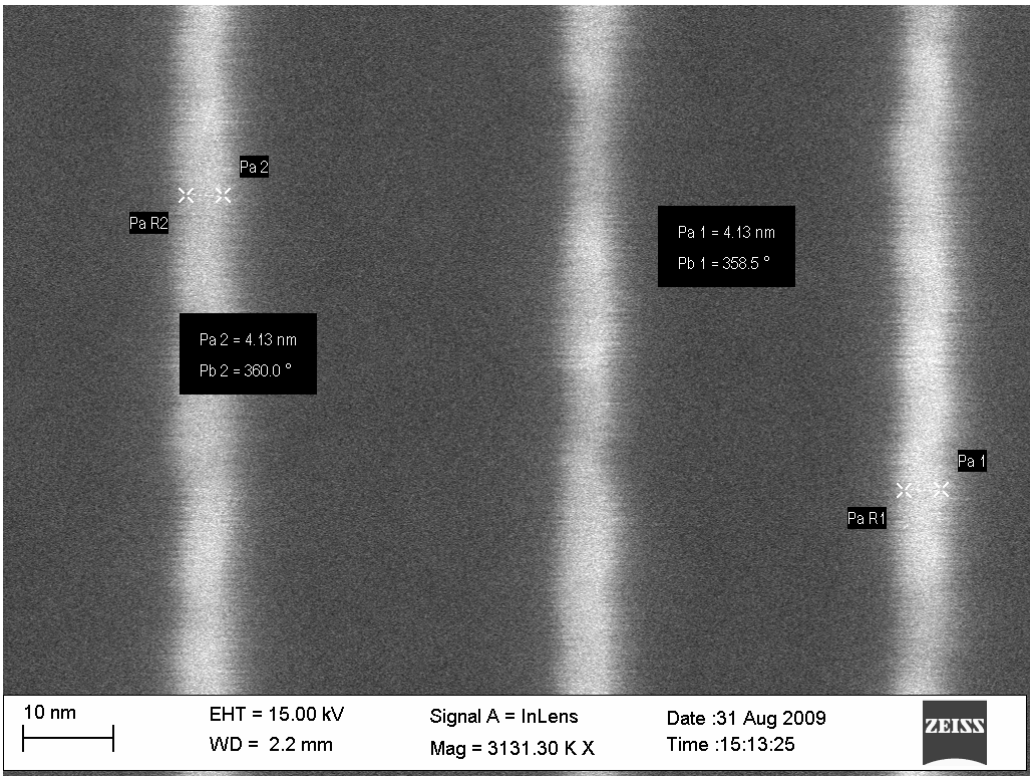
Our system is capable of carrying out the de-convolution of the energy density distribution (EID) function presented in the tabular form with the special emphasis on the forward scattering range. The spot size and the spot placement in the virtual address grid is analyzed and considered with 1Å resolution. This results in the precise compensation method which considers energy distribution of the complete scattering effects.

In this communication, we report on our experimental results from the study on the e-beam writing strategies combined with the forward scattering proximity term compensation. Successful sub-10nm patterning with dimension controllability better than 10% of the CD was achieved. The experimental setup uses JBX-9300FS (used @ 100keV) as exposure tool, HSQ (XR-1541) as the resist. The EID function was calculated by CHARIOT.

Keywords: PATACON PC-Cluster, E-Beam, PEC, CHARIOT, HSQ, JBX-9300FS.



Grating with 6nm CD lines.



Grating with 4nm CD lines.