IP-5 Reducing the Size of a Rectangular-Shaped Electron Beam in E-Beam Writing System.

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This contribution deals with an electron-beam writing system working with fixed energy of 15 keV and a rectangular variable-size beam shape (Fig. 1). Basic step of beam deflection is 100 nm, basic step of beam shaping is 100 nm, the size of the shaped beam can be from 100 to 6300 nm independently in both directions (Fig. 2). The aim of the stamp reduction is to decrease the step of shaping system to 50 nm and to increase the writing speed with four times higher current density [1], [3].

A rigorous analysis was performed with EOD program [2] resulting in the feasibility study of reducing the stamp size after the shaping stage by changing the excitation of the C3 lens. Standard operation requires the C3 current of ~ 0.13 A resulting in shutter magnification of 0.0654; in the new mode the excitation current is increased to ~ 0.19 A reducing the magnification to ~ 0.032. The shape of the stamp is rotated by 45 degrees against deflection system axis (Fig. 3). Testing exposures show the successful operation (Fig. 4, dashed square represents the original size of 3 micrometer stamp).

Increasing the beam current density has a direct impact on the stamp writing speed. However, the time required for one stamp is composed of stamp-exposure time and data-transfer-overhead time. Using a new communication module between the control PC and the electronics module decreased the second one. The time of a typical exposure (600 million stamps) was reduced from 10 hours down to only 2.5 hours.

With the reduction of the beam size, we also investigated the ways to reduce the beam deflection step. Three approaches were used: (1) increased resolution of the deflection digital to analog converter, (2) exploitation of a 70 nm step in a diagonal direction, and (3) software correction of a stamp position by double exposure with appropriate stamp-time settings.

A unified C3-lens power supply will be modified for switching between the two offset currents for both the original and improved modes. Control software for this supply will be updated. Important will be also improvements of the pre-exposition data processing tool.

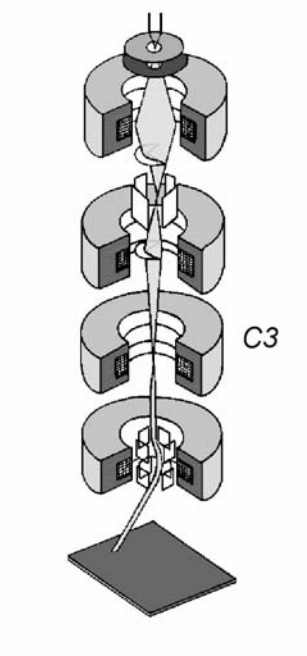

Figure 1 Electron-optical system

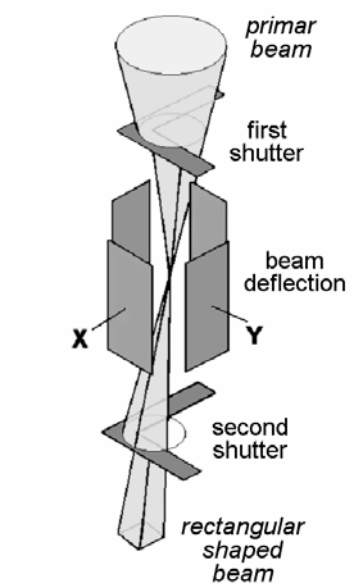

Figure 2 Beam shaping module

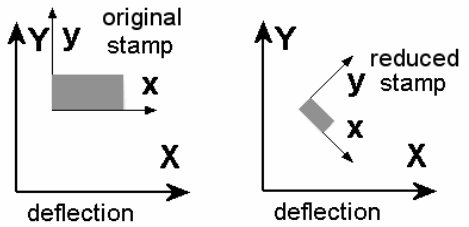

Figure 3 Size and orientation of the reduced stamp

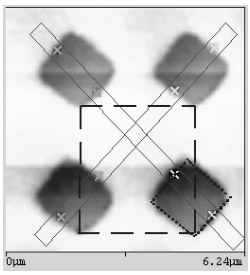

Figure 4 AFM image of 1.5 micrometer square stamp

References:
[1] Kolařík V. et al., Towards the sub-100nm e-beam writing system. Conference Nano '05. ISBN 80-214-3044-3. Brno 2005.
[2] Lencová B., A New Program for the Design of Electron Microscopes, Abstracts of CPO7, Cambridge 2007, (available at www.mebs.co.uk)
[3] ISI AS CR, http://www.isibrno.cz/teams/EBL/ (in Czech)

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