A Novel Magnetic Microstigmator for Electron Beam Astigmatism Correction in the Electron Beam Microcolumn System

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This paper presents a novel magnetic microstigmator (MMS) for correcting the electron beam astigmatism in an electron beam microcolumn system (EBMCS). The EBMCS has wide applications in E-beam nanolithography, portable electron microscope, etc.[1-3] The astigmatism deteriorates the shape of the electron beam probe and degrades the resolution of the electron beam device. Compared to its electrostatic counterpart, the magnetic stigmator has lower aberrations and higher sensitivity. The utilization of MMS can greatly reduce the power consumption, the fabrication cost, and the size of the EBMCS. The designed MMS consists of eight magnetic poles coupled with solenoid-type microinductors which are divided into four pairs (Fig 1(a)). Each pair of the microinductors is composed of two micromachined solenoid coils and a permalloy (81%Ni/19%Fe) magnetic core. The operational principle of the proposed MMS for correcting the electron beam astigmatism is illustrated in Fig 1(b). When a ray of electron beam carrying astigmatism passes through the central bore area of the MMS (Fig 1(b)), the magnetic field produced by the four pairs of the microinductors will exert Lorentz forces on different portions of the electron beam. The direction and the strength of the forces are determined by the magnetic fields produced by the eight magnetic poles. Fig 2(a) shows the microphotography of the MMS fabricated by using the microfabrication technology. The distance between the two opposite magnetic poles is 1 mm, and the size of the diced chip is 1cm × 1cm. The fabricated MMS was assembled into an EBMCS for testing (Fig 2(b)). Figure 3 shows the current images of the copper grid sample (400 mesh) obtained by the EBMCS before and after applying a driving current of 300 mA to the assembled MMS. It clearly shows that by using the developed MMS, the original deformed grid image resulting from the electron beam astigmatism is effectively corrected into a square shape. The preliminary experimental results demonstrate that the developed magnetic microstigmator has excellent capability in correcting the electron beam astigmatism with low power consumption in the EBMCS.

REFERENCE

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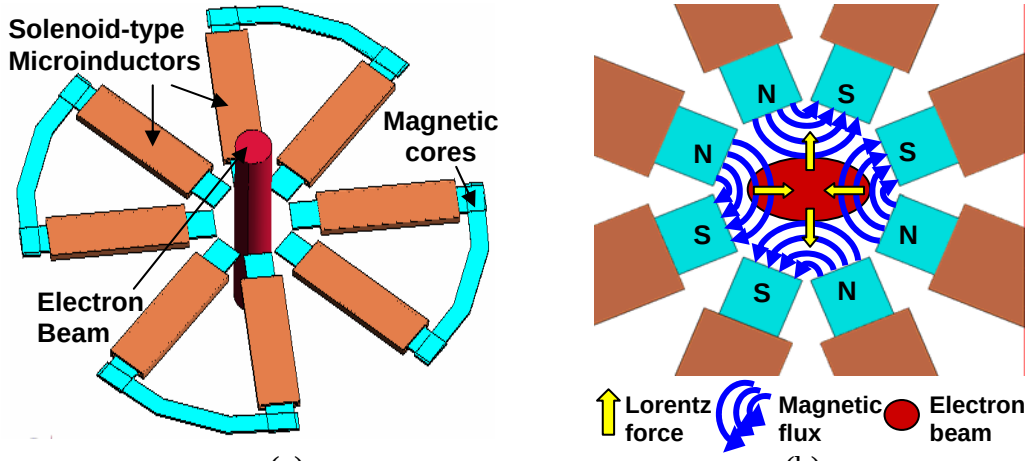
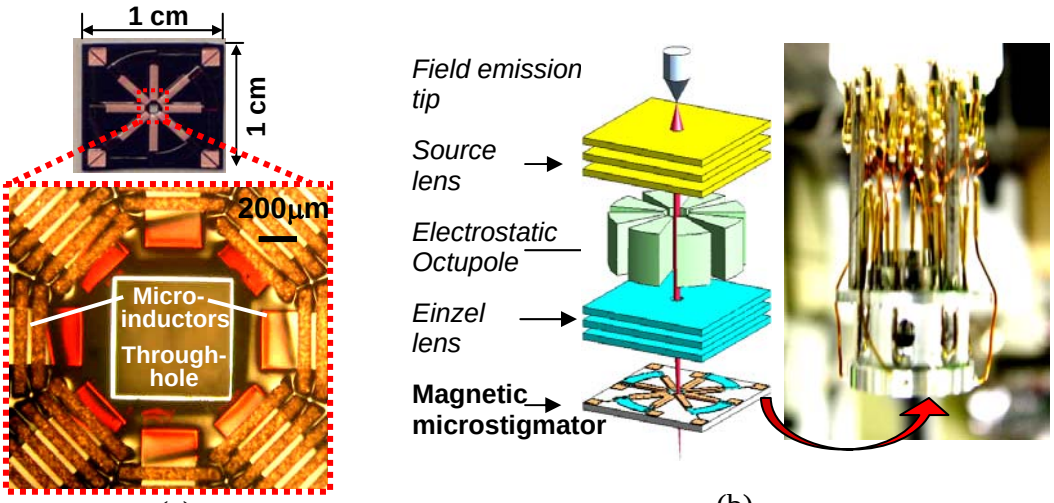


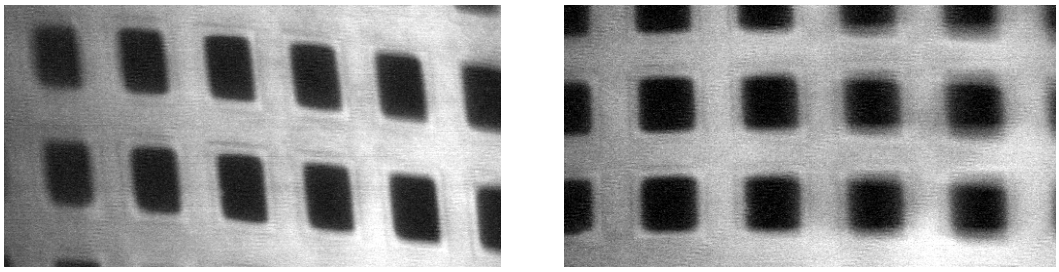
(a) (b)

Fig 1: Designed magnetic microstigmator: (a) schematic view and (b) top view.



(a) (b)

Fig 2: (a) Fabricated magnetic microstigmator and (b) an EBMCS assembled with the developed magnetic microstigmator.



(a) (b)

Fig 3: Current images of the copper grid specimen (400 mesh): (a) before and (b) after a 300 mA driving current applied to the magnetic microstigmator.