

ELECTROSTATIC DEFLECTION SYSTEM FOR FOCUSING MULTI-BEAM ELECTRON SOURCES

Mathias Bartl¹, Matthias Hausladen¹, Josef Sellmair¹, Philipp Buchner¹, Ali Asgharzade¹, Kamil Baranowski², Michal Krysztof², Daniel Burda³, Alexandr Knápek³, Dennis Kepic⁴, Simon Edler⁴, Andreas Schels⁴, Michael Bachmann⁴ and Rupert Schreiner¹

¹ Faculty of Applied Natural Sciences and Cultural Studies, OTH Regensburg, D-93053 Regensburg, Germany

² Faculty of Electronics, Photonics and Microsystems, Wrocław University of Science and Technology, 11/17 Janiszewskiego St., 50-372 Wrocław

³ Institute of Scientific Instruments of the Czech Academy of Sciences, Královopolská 147, 612 00 Brno, Czech Republic

⁴ Ketek GmbH, D-82737 Munich, Germany

Corresponding author: mathias.bartl@oth-regensburg.de

ABSTRACT

This work demonstrates the focusing capabilities of electrostatic optics designed for focusing of multiple electron beams originating from different emission sites. Focusing is achieved using a two-stage system. First, the various electron beams are deflected so that they meet at a central point. Since the emission tips were placed on concentric circles, all electron beams belonging to a circle can be deflected using common structures. The usage of a SOI wafer allows the integration of these so-called deflectors directly on the extraction grid. The SEM image in Figure 1a shows the resulting radially symmetrical structure of the deflectors. A macroscopic einzel lens is used to produce a miniaturized image of this superimposed electron beam, resulting in a focusing effect. The feasibility of this two-stage approach is demonstrated by a FEM-simulation (Figure 1b). The electrostatic optics were characterized both individually and in combination with each other using a highly defined electron beam from an SEM (Jeol JSM-6400F) and with self-fabricated emitters (e.g. [1]). Using the electron beam of a SEM allows the properties of the electrostatic optics to be pre-examined without being influenced by non-ideal effects caused by real emitters. A CMOS image sensor was used for the visualization of the general emission pattern of the multi beam electron source and the changes of the pattern caused by the electrostatic optics [2].

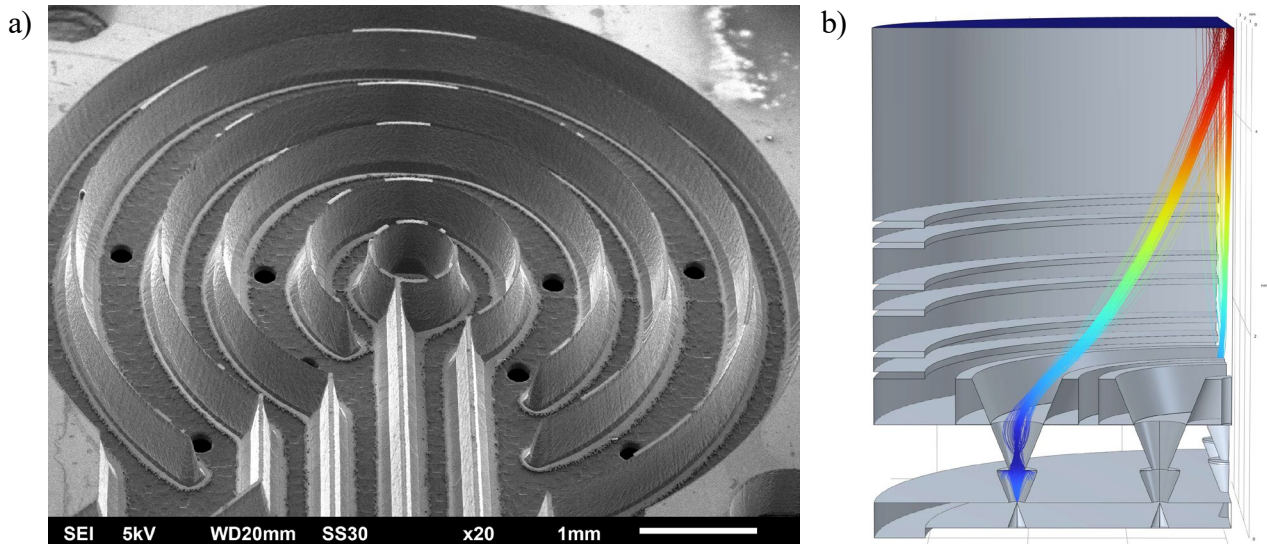


Fig. 1. a) SEM image of deflector structures integrated on an extraction grid used for deflecting multiple electron beams on a central point. The extraction holes of the grids are placed on concentric circles. Each circle is surrounded by an inner and outer deflector. b) Simulated electron trajectories for a combination of deflectors and single lens optics.

References

[1] C. Langer et al., J. Vac. Sci. Technol. B, vol. 38, no. 1, (2020), doi: 10.1116/1.5134872.

[2] M. Hausladen et al., J. Vac. Sci. Technol. B, vol. 42, no. 6, (2024), doi: 10.1116/6.0004074.