Design of small low energy electron gun

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The electrical defect, such as open circuit, short circuit or leakage, can only be detected by an electron beam in extremely large scale integrated circuit (ELSIC) defect detection. However, in order to enhance the contrast of defects and improve the signal-to-noise ratio of defect images, it is necessary to establish surface voltage or charge distribution by pre-scanning of electron beam. In addition, the residual static electricity on the surface of the sample will affect the electron beam focusing imaging.

In this paper, a low energy supplementary electron gun was designed. In order to improve the efficiency of the main electron beam in defect detection, the supplementary electron beam can be used for charge neutralization and pre-scanning [1, 2]. At the same time, the damage to the sample can be avoided. Considering the space limitation and thermal radiation, it can be integrated near the main electron gun objective lens. In order to ensure the size and uniformity of the beam spot, the finite element method is used to analyze the electronic optical characteristics and the influence of different geometrical shapes of the electrostatic lens [3]. The results showed the beam spot diameter can be more than 4mm at the working distance of 3~4mm, the energy of the electron beam is 1000eV, and the beam current is 100~600μA.

[1]J. Z. Gleizer, V. Vekselman, S. Yatom, J. Felsteiner, and Y. E. Krasik, "Low-energy electron beam source." Radiation Effects & Defects in Solids, 2011, 166(6), 389-398.
[2]P. W. Erdman, E. C. Zipf. "Low-voltage, high-current electron gun." Review of Scientific Instruments, 1982, 53(2): 225-227.
[3]E. Plies, "Electron optics of low-voltage electron beam testing and inspection. Part I: simulation tools." Advances in Imaging and Electron Physics. 2018, vol. 205, 139-267.

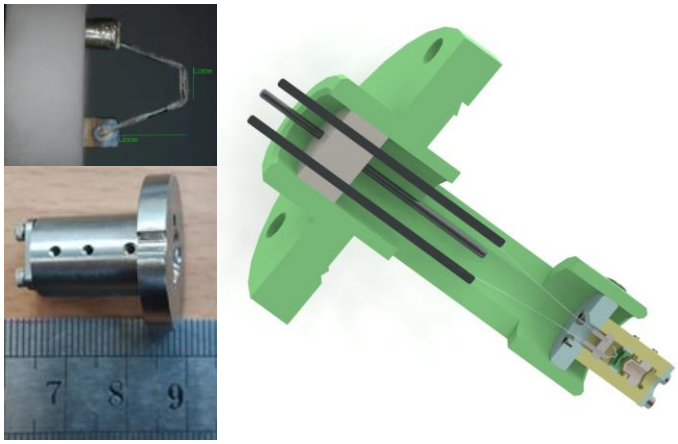

Figure 1: The electron gun: the photograph in the top left is 1 mm diameter tantalum cathode, and the bottom left is the external view of electron gun. This gun can be integrated into the main gun or used independently as shown in the right.

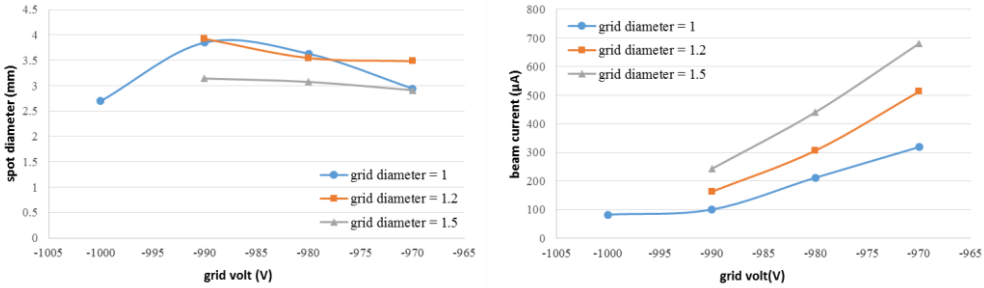

Figure 1: numerical calculation: the chart in the left is the relationship between grid voltage and spot diameter with different grid diameter at 1000eV, and the right is the relationship between grid voltage and beam current with different grid diameter at 1000eV at the working distance.